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Re-evaluating California's greenhouse gas emission law: Is it rational under the current economic situation?

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ABSTRACT SUMMARY

This research evaluates the impact of the economic recession on the California Air Resource Board (CARB) strategy for reducing current greenhouse gas (GHG) emissions from motor vehicles. The principle potential contribution of this work is that it evaluated whether the rationale behind the CARB strategy is or is not valid under the current, unanticipated economic recession.

ABSTRACT

In 2002, California acknowledged the scientific consensus that global warming is a serious threat to the welfare of California's citizenry and environment. This concern resulted in the California State Assembly Bill 1493 (Pavely) which was signed into law that year. AB 1493 directs the California Air Resources Board (CARB) to adopt regulations which achieve the "maximum feasible and cost-effective" reduction of GHG emissions from motor vehicles. The bill also required CARB to set its emissions standards with the goal of reducing not just the environmental impacts, but also the economic impacts of global warming, including impacts on jobs, businesses and California businesses competitiveness with other states.

In response to these requirements, CARB implemented the regulation as new vehicle performance standards across the industry and performance beyond these standards would be tradable between classes of vehicles as well as between manufacturers. The new GHG regulations were added to preexisting Low Emission Vehicles (LEV) standards, which have regulated criteria pollutants that relate to air quality and public health since 1994. Based on the economic data available in 2002, CARB finalized regulation implementing AB 1493, adopting a set of maximum greenhouse gas emission levels. Automakers were charged with the design of a mix of vehicles and might take other alternatives to meet the emission standards starting with 2009 year.

However, since 2007, an economic recession has taken place in the world, affecting not only the economies of the United States where it began, but also where it has spread to many other countries such as China, Russia and the European Union. This recession has created serious obstacles for the United State's economic growth, for businesses and for the economic and environmental welfare of its citizens. In California specifically, business employees, the automotive and housing industries have suffered the most since the recession began. This economic downturn has made the 2002 data which CARB relied on to support its regulation methodology extremely inaccurate with regard to predicting present economic conditions as well as the size and makeup of the new vehicle fleet. Because of this inaccuracy, implementation of the regulations as they stand now would fall short of achieving the directives of AB 1493. Because of falling sales of new cars, and especially hybrid cars caused by the recession, it has also

become very difficult for automakers to meet the requirements of AB 1493 and the CARB regulations while still remaining economically viable companies.

This research examines the economic concerns of the automotive industry in meeting the GHG emissions standards set by CARB by examining the validity of these standards under the current economic recession. This work presents full understanding of how these standards were functioned in the 2009-2010fiscal year and whether if these standards were or were not valid for the same fiscal year. However, the findings of this research paper have shown that the proposed GHG emission standard by CARB is valid under the economic recession.

BACKGROUND

The California Air Resources Board (CARB) published a report in August, 2004 with recommendations for greenhouse gas (GHG) emissions reductions in newly manufactured passenger cars and light-duty trucks[1]. The CARB report and the subsequent regulations recommended by it were directed by California State Assembly bill AB 1493 passed in 2002. The regulations would require new automobiles sold in California to adhere to decreasing emissions with each subsequent model year beginning in 2009 and ending in 2016. The 2004 CARB report and its 'Statement of Reasons' for its recommended emissions standards are understood as follows:

Climate change occurs naturally on Earth over time and in very small increments. However, in the 20th century the rate of climate change has increased dramatically and without historical precedent. Climate change is measured several ways, e.g. through increased average temperatures, reduction in spring runoff and rising ocean levels due to melting polar ice. Climate change is caused chiefly by higher concentrations of GHGs, which include CO2, CH4, and NO2, ozone and hydroflourocarbons which trap heat inside Earth's atmosphere. These elevated GHG levels are caused in large part by automobile exhaust emissions. This recent 'global warming' is indisputably man-made, and the only questions lie in how much time and in what parts of the world serious damage will occur.

Reducing emissions from motor vehicles is one way to reduce the speed at which the global climate changes, and will allow for a smoother transition to a changing planet.

[1] California Environmental Protection Agency, "Staff Report: Initial Statement Of Reasons For Proposed Rulemaking, Public Hearing To Consider Adoption Of Regulations To Control Greenhouse Gas Emissions From Motor Vehicles." August 6, 2004. http://www.arb.ca.gov/regact/grnhsgas/isor.pdf, (accessed March 23, 2009)

Slowing global warming will reduce damage to the environment as well as the economy and therefore be beneficial to all.

AB 1493 requires that emissions reduction be economical for the vehicle owner for the life of the vehicle. Research was done to assess the baseline values of current emissions and what existing technologies could be installed in 2009 to begin reducing emissions across the board. The research shows that emissions lowering technologies offset their cost by reducing the lifetime operating cost of the vehicle.

Vehicle GHGs come from four sources: (1) Operation of the vehicle; (2) Using the vehicle's air conditioning; (3) Refrigerant leeks from inefficient air conditioning systems; and (4) Fuel production costs upstream from the vehicle owner.

The new standards proposed pertain to two classes of vehicle: (1) Passenger cars and light-duty trucks1 (PC/LDT1); and (2) light-duty trucks2 (LDT2). Emission standards were developed by applying the maximum feasible reduction of emissions to several vehicle types. The standards were then applied to the most weighty vehicles across the range of different manufacturers in order to make the standards possible to meet by all major companies.

The standards recommended to fulfill the mission of AB 1493 are:

Table ES-1: CO_2 Equivalent Emission Standards for Model Years 2009 through 2016. [2]

[2] California Environmental Protection Agency, "Staff Report: Initial Statement Of Reasons For Proposed Rulemaking, Public Hearing To Consider Adoption Of Regulations To Control Greenhouse Gas Emissions From Motor Vehicles." August 6, 2004. http://www.arb.ca.gov/regact/grnhsgas/isor.pdf, (accessed March 23, 2009)

Tier	Year	CO_2-equivalent emission standard by vehicle category (g/mi)	
		PC/LDT1	LDT2
Near-term	2009	323	439
	2010	301	420
	2011	267	390
	2012	233	361
	2013	227	355
Mid-term	2014	222	350
	2015	213	341
	2016	205	332

The standards are built to be achievable by the manufacturer with the worst starting emissions level so success will be possible for all manufacturers. Consumer cash flow analysis find that consumers would save between $6.14 and $11.73 in reduced operating costs after purchasing fully phased in vehicles (by 20

These are the reductions in emissions from cars manufactured by the major six manufacturers over the years of the near and mid-term phase in:

Table ES-2: Average Cost of Control by Model Year for the Major Six Automakers.[3]

[3] California Environmental Protection Agency, "Staff Report: Initial Statement Of Reasons For Proposed Rulemaking, Public Hearing To Consider Adoption Of Regulations To Control Greenhouse Gas Emissions From Motor Vehicles." August 6, 2004. http://www.arb.ca.gov/regact/grnhsgas/isor.pdf, (accessed March 23, 2009)

Year			All major 6
2009	Near-term phase-in	PC/LDT1	16
		LDT2	36
2010		PC/LDT1	52
		LDT2	93
2011		PC/LDT1	194
		LDT2	199
2012		PC/LDT1	292
		LDT2	308
2013	Mid-term phase-in	PC/LDT1	330
		LDT2	382
2014		PC/LDT1	383
		LDT2	491
2015		PC/LDT1	483
		LDT2	723
2016		PC/LDT1	626
		LDT2	955

AB 1493 provides for credits to be given to manufacturers for emission reduction ahead of the schedule provided in this report.

The environmental impact of vehicles following the new standards described here as 87,400 CO2 equivalent tons per day less by 2020 and by 154,500 CO2 equivalent tons per day less by 2030. This is an 18 percent overall reduction in emissions from light duty vehicles by 2020 and a 27 percent reduction by 2030. Baseline emissions in 2004 are estimated at 386,600 CO2 equivalent tons per day and will be 430,200 CO2 equivalent tons per day by 2010 if no action is taken.

The reduction of emissions is illustrated here:

Table ES-3: Average Percent CO_2 Emission Change by Vehicle Model Year.[4]

[4] California Environmental Protection Agency, "Staff Report: Initial Statement Of Reasons For Proposed Rulemaking, Public Hearing To Consider Adoption Of Regulations To Control Greenhouse Gas Emissions From Motor Vehicles." August 6, 2004. http://www.arb.ca.gov/regact/grnhsgas/isor.pdf, (accessed March 23, 2009)

Year			All major 6
2009	Near-term phase-in	PC/LDT1	-1.3%
		LDT2	-2.1%
2010		PC/LDT1	-4.4%
		LDT2	-5.5%
2011		PC/LDT1	-14.0%
		LDT2	-11.8%
2012		PC/LDT1	-24.9%
		LDT2	-18.3%
2013	Mid-term phase-in	PC/LDT1	-26.7%
		LDT2	-19.6%
2014		PC/LDT1	-28.5%
		LDT2	-20.9%
2015		PC/LDT1	-31.2%
		LDT2	-22.9%
2016		PC/LDT1	-33.9%
		LDT2	-24.8%

Emissions of the kind addressed in this report from California represent less than one percent of the entire world's light duty vehicle emissions, but when taking into account public support of this effort as well as the efforts of many other states and nations to implement similar standards, doing nothing seems like an unattractive course of action. The cost effectiveness of these regulations is also a compelling reason to implement them. For each ton of CO2 equivalent gases reduced there will be $138 saved in 2020 and $135 in 2030.

More pessimistic economic concerns have been addressed by this report's research in response to a few possible negative scenarios, but the net effect on business in California even with increased car prices due to the cost of new emissions reducing technology is still positive with respect to the California economy. Low income and minority income communities are not expected to be negatively impacted either. Sales of new cars across the board are expected to dip only in the mid-term period of increased standards, and then only a slight decrease is projected.

The numbers in this report are based on a $1.74 per gallon fuel price, which some might say is an unrealistic figure, so CARB did try the same scenarios using $2.30 fuel price as well and found that the program still eventually paid back buyers through reduced operating costs, but that this pay-back scenario took longer than at the lower fuel price.

ECONOMIC RECESSION

The National Bureau of Economic Research stated on December 1st, 2008 that the U.S. economy had been in recession since December of 2007. It began by the sudden collapse of the artificially inflated U.S. housing market. This event caused a credit freeze which affected banks across the country and the globe. The recession continues into 2009 with no sure indicator of when it will end. This recession has been accentuated by a severe downturn in consumer spending and unemployment levels which have not been experienced in the U.S. in two decades.

California's economy has been hit harder than the U.S. at large. Wages fell more in the second half of 2008 than in the first even though parts of the U.S. had already begun to recover: "According to the U.S. Commerce Department, total personal income grew more slowly in the second half than in the first half of 2008," reports the California Department of Finance. Unemployment continues to decrease as struggling business lay off workers. Through the beginning of the downturn through till November of 2008, California lost 147,400 jobs, or 13,400 jobs per month. Retail sales fell by 4 percent between the second and third quarter of 2008. A deceleration in new vehicle registrations started in 2007. [5]

The table in the next page shows the decline in retail sales for California from 2007 through the third quarter of 2008 as reported by the California Department of Finance:

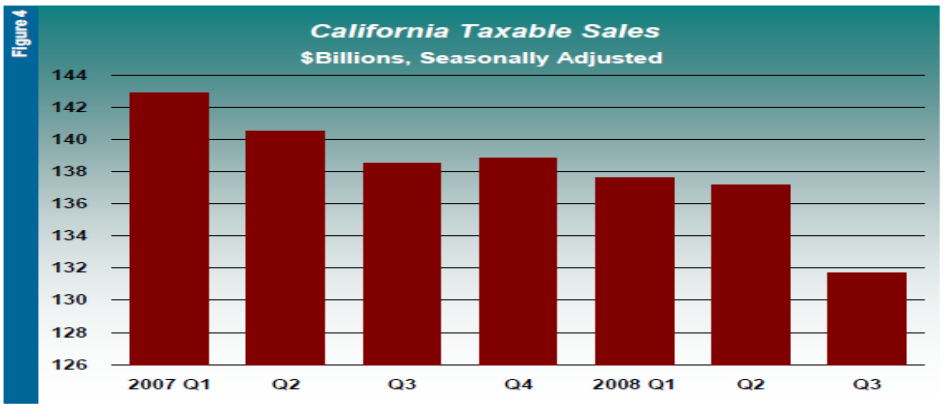

Figure 4

[5] California Economic Indicators, "A Widespread Slowdown." 2009. http://www.dof.ca.gov/HTML/FS_DATA/indicatr/documents/CEI0902FINAL.pdf , (accessed April 1, 2009).

Private-sector nonresidential building is also slowing and will be down considerably from 2007. The value of permits fell every month from July to November.[6]

This research was proceed under the assumption that the current recession raises concerns among automakers about the economic consequences of complying with current CARB emissions standards. Hopefully these concerns provides strong motivation for the industry to put pressure on CARB to adjust their standards to current market conditions. A change to the CARB regulation must occur for the directives of AB 1493 to be met[7].

RESEARCH OBJECTIVES

Studying and identifying the impact of the economic recession on the state of California's market is an important point of this work. This research creates a more current market data set serving as a powerful motivator for driving CARB to reevaluate and review the current GHG emissions standards. This research attempts to enhance and develop the current greenhouse gas standards for California motor vehicles in light of more current economic and environmental conditions than are currently pointed to in developing them. It is hoped that the knowledge and information generated by this work contributes to and serve to advance the understanding of what appropriate GHG emissions standards for California should be in keeping with the directives of AB 1493.

What does this research offer?

- A Full understanding of how the current GHG emissions standards measure against the purpose of AB 1493 and the obstacles which must be overcome to meet said purpose.
- A data set of current economic and market conditions as they apply to GHG standards.
- A contribution to the development of correct GHG emissions standards for the use and adoption of CARB and implementation by automobile manufacturers.

[6] California Economic Indicators, "A Widespread Slowdown." 2009. http://www.dof.ca.gov/HTML/FS_DATA/indicatr/documents/CEI0902FINAL.pdf , (accessed April 1, 2009).

[7] Johnson, K. C., "California's greenhouse gas law, Assembly Bill 1493: Deficiencies, alternatives, and implications for regulatory climate policy". Energy Policy v. 35 no. 1 (January 2007) p. 362-72

1. Literature Review

Since the 2002 passing of California AB 1493 much literature has been published regarding the state emissions standards in California. The California Air Resources Board offers on its website a comprehensive set of documents explaining the entire methodology and history of rulemaking during the long, unfinished process of adopting emissions standards for new California motor vehicles. Every change in policy and criticism from public and private sources is available to researchers.

Likewise, there is just as much if not more data regarding the recent economic recession as it affects California and the United States as a whole. The California State government provides on its website comprehensive economic data including unemployment and wage statistics, retail sales figures for cars and hybrid cars and consumer confidence projections into the future as well. Every national news organization as well as many academic institutions across the country are publishing articles and peer-reviewed studies examining the causes and impacts of the global economic crisis.

1.1. Assembly Bill 1493 I (Pavely) Regulation and the CARB Greenhouse Gas Standards.

A Call for Change

The Alliance of Automobile Manufacturers have sent a report to CARB offering a refutation of CARB's proposed regulations, stating that the regulations as proposed would increase criteria pollutant emissions from the California automobile fleet. The three reasons the Alliance cited in their argument were: 1. That higher prices on new, cleaner vehicles would cause a drop in sales which would stall their introduction into the fleet. 2. That since the clean vehicles would cost less to operate, owners would drive them more causing a net increase in GHG emissions. 3. That the CARB predicted fuel cycle emissions reductions were exaggerated.

CARB's Incorrect Methodology

Kenneth Johnson points out three main deficiencies the CARB GHG standards[8]

First, Incorrect calculation methodology:

Johnson states that the CARB methodology requires that "the bi-level standard be sales average matched to the regression standard within each separate LEV class,"[2] and that this methodology is inappropriate as emission trading is allowed between vehicle classes and not just within them. This trading allows for a "performance

[8] Johnson, K. C., "California's greenhouse gas law, Assembly Bill 1493: Deficiencies, alternatives, and implications for regulatory climate policy". Energy Policy v. 35 no. 1 (January 2007) p. 362-72

compromise"[2] which is only due to miscalculation and not from an effort to satisfy the affected parties.

Second, LEV-compatibility constraint:

The CARB emissions standards are calculated from the "regression standard"2 of maximum possible reductions made possible by the implementation of reduction technologies, and then adjusted it to the sales figures of the 2002 California fleet of light duty vehicles. Johnson states that if fleet conditions were to change significantly from the 2002 based "bi-level" standard, then the original regression standard would no longer be met.

Third, Conflicting policy objectives:

AB 1493 is at odds with itself in terms of its stated mission versus the guidelines it gives to CARB for forming emissions reduction regulations, as economic feasibility of such standards is placed before the environmental goals of the bill.

The future consequences of implementing present CARB standards:

1. David Regan, VP of Legislative Affairs for the National Automobile Dealers Association (NADA) states: "Separate and apart from the stringency of standards set by the federal government or California, the establishment of 13 state-based fuel economy regimes would cause irreparable harm to an already struggling automobile industry."[9] The NADA believes that having anything but one national emissions standard will incur costs great enough to destroy the industry they represent.

1.2. Economic Recession VS. The California Auto Market

The economic recession which began in 2007 and has continued through to the present has had a negative influence on three sectors of the California economy: Loss in average income for Californians, loss in sales for passenger cars and light duty trucks, and losses in sales of hybrid gas/electric (green) vehicles. According to governor Schwarzenegger's '09-'10 budget report, growth in consumer income has dropped precipitously, falling by 1.7 percent between 2008 and 2009.[10] Ross DeVol describes

[9] Washington Area New Automobile Dealers Association http://www.wanada.org/userfiles/pdf/NADA-TellsEPA[web-copy].pdf (Accessed 2009)

[10] Governors'' Budget 2009-10, "Proposed Budget Summary Economic Outlook (2009), 1, http://www.ebudget.ca.gov/BudgetSummary/ECO/1249562.html, (accessed April 11, 2009).

the slumping state of consumer spending in California and some of its causes: "Consumer spending is no longer an engine propelling the economy forward. Declining payrolls, falling home prices, onerous debts, tighter credit conditions, and high oil prices are pinching the ability of consumers to spend. These pressures weigh heavily on consumer psychology, as well. Consumer sentiment, as measured by both the University of Michigan and The Conference Board, has fallen to levels consistent with past recessions. Consumer spending is still increasing in nominal terms, but rising inflation has masked the fact that real purchases on durable goods are no longer growing. In each of the past five months through March 2008, real spending fell, while nondurable spending dropped in each of the past three months."[11]

There is a strong correlation between slowed income growth and lowered consumer confidence, and lack of robust spending on consumer goods. This is a very different picture of the California economy than is described by the 2002 figures used by CARB to calculate an emissions reduction model. "California lost more than 100,000 jobs in the past year, and its unemployment rate is 8.2 percent Statewide—the highest in 14 years,"[12] states the junior U.S. Senator from California, Barbara Boxer. Large increases in the California unemployment rate due to the recession contribute to lower average incomes state wide. Jobless Californians are not in the position to make major investments in costly consumer goods such as new cars, and are more likely to keep repairing older, less fuel efficient vehicles. The decline in car sales due to the recession fallout is made clear in a letter written by the California New Car Dealers Association to U.S. Treasury Secretary Timothy Geithner on 23 Feb. 2009 asking for federal economic assistance for its members, citing that "California new car dealers sold 433,570 fewer cars and trucks in 2008 than the year before (a 23% decline vs. 18% nationwide)."[13] "Auto sales were very weak in March (2008), coming in at an annual rate of just 15.1 million units, a decline of 12.0 percent from March 2007."[14] These numbers correlate with the timing of the recession, and California has been hit harder than the United States as a whole. If consumers have less and less money to spend, and no secure jobs to make them confident in their future earnings, then they are much less likely to buy new cars at pre-recession levels, and certainly nothing near 2002 levels.

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[11] DeVol, Ross. "The Economic Outlook for the United States and California: Slow Growth or Recession? (2008), http://www.milkeninstitute.org/pdf/EconomicOutlook050708.pdf., (accessed March 16, 2009).

[12] BOXER, BARBARA . "THE REALITIES OF RECESSION(2008), http://boxer.senate.gov/features/Boxer_California_Recession_Report.pdf.(accessed April 10, 2009).

[13] California New Car Dealers Association, CNDA. "Crisis In Dealer Floorplan Lending Will Exacerbate Job Loss(February 23, 2009), Page 1, http://cncda.org/resources/CNCDA_Letter_to_Mr_Geithner_2-23-2009.pdf, (accessed April 18 , 2009).

[14] DeVol, Ross. "The Economic Outlook for the United States and California: Slow Growth or Recession? (2008), http://www.milkeninstitute.org/pdf/EconomicOutlook050708.pdf, (Accessed March 16, 2009).

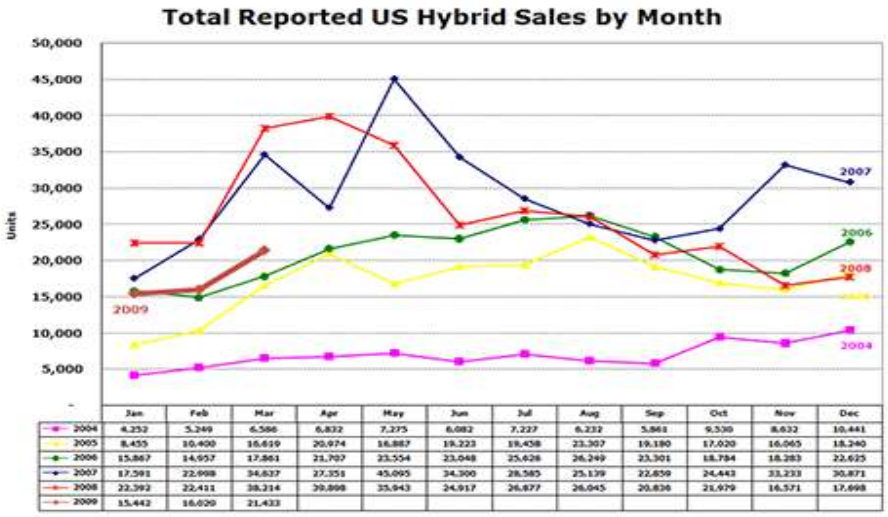
In addition to the downward trend in total car sales, the L.A. Times reported on March 17th that hybrid car sales per month have dropped by over 15,000 gas/electric hybrids from December 2007 to February 2006.[15] CARB recommended a set of technologies that automakers could choose to reduce CO2 emissions from their new cars, thus implementing the new GHG standards. One of these technologies is the continuously variable transmission (CVT). CVT allows for an infinite number of gears and is usually operated by a belt or chain, similar to the way a bicycle transmission operates. CVTs are gaining popularity in the U.S. and are currently being offered in both hybrid vehicles and some conventional cars. Another recommended technology is lower carbon fuels. Fuels such as ethanol, hydrogen, electricity and natural gas used as a total fuel source or as part of a gasoline/low carbon fuel blend in either conventional or hybrid vehicles can significantly reduce CO2 emissions from vehicles[16]. However, the current economic recession is playing a significant role in undermining the sales of alternatively fueled or hybrid "green" cars, as "The light duty vehicle sales stats for March 2009 show a 36.8% drop by volume compared to March 2008, and March 2008 probably didn't break any records in the first place... But hybrid cars are doing even worse than that: minus 44% in March 2009."[17]

The following two diagrams show the reported Hybrid cars sold in the US by the largest hybrid manufacturers: Ford, Nissan, Toyota, GM and Honda: In this diagram, the reported sale of hybrid cars for the first three months of 2009 is less than in the first three months of 2008 or even in 2007, indicating that the sale of this type of car is decreasing and not in keeping with what CARB assumed the hybrid fleet would be when they calculated the GHG reduction standards. This adds to the impact of the decrease in light car sales overall, making the currently adopted GHG standard to be less effective and accurate than if current figures were used in its calculation.

[15] Bensinger , Ken . "Hybrid car sales go from 60 to 0 at breakneck speed(March 17, 2009), Page 1, http://articles.latimes.com/2009/mar/17/business/fi-hybrid17, (accessed April 20, 2009).

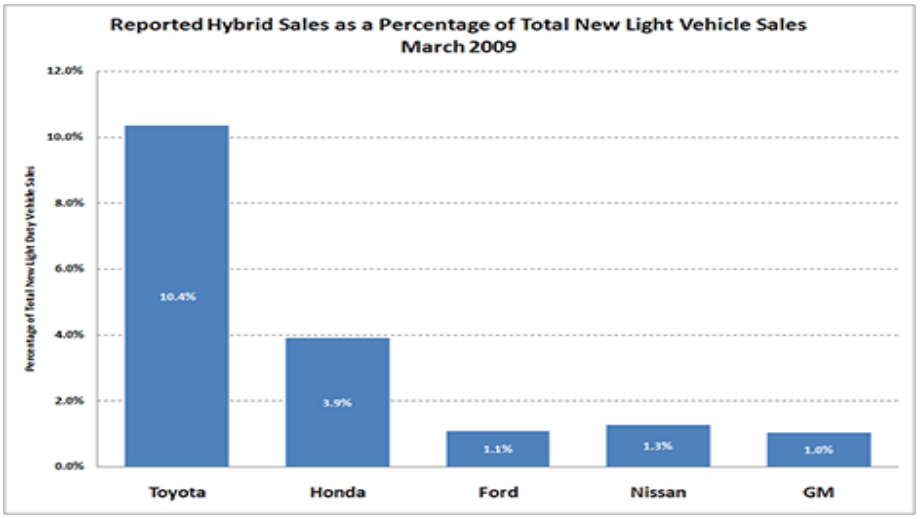
[16] Clean car campaign, "Off-the-Shelf Technologies", July 2004, http://www.calcleancars.org/factsheets/offshelftech.pdf. (Accessed April 16, 2009).

[17] Richard, Michael Graham. "U.S. Hybrid Car Sales in March... Not Good At All (2009), http://www.treehugger.com/files/2009/04/us-hybrid-car-sales-down-44-percent-march-2009.php. (accessed April 16, 2009).



In the next diagram, the largest automakers are shown to be selling very few hybrids as a percentage of overall new car sales[18]. Unfortunately, CARB predicted that four of the automakers shown here would be selling far more new hybrids, proving again that their methodology in setting GHG reduction standards is flawed and must lead to inaccurate results and inadequate emissions reduction.

[18] Green car congress, "US Hybrid Sales in February Drop 29%; Lower Decline Than General LDV Market(February 2009), http://www.greencarcongress.com/2009/03/us-hybrid-sales.html#more. (accessed April 1, 2009).



The primary reason, of course, for this decrease in hybrid car sales in the U.S. is the current economic recession. This statement puts the cause in no uncertain terms: "It's the Economy, Stupid: the first, and biggest factor, is of course the economic recession. This has two effects on potential hybrid car buyers: 1) They have less money in their pockets, so might opt not to buy a car at all, or to buy a less expensive model, and 2) less economic activity = less demand for energy = lower oil prices (more or less), which makes fuel efficient hybrids seem like less of a good deal (unlike when gasoline was $4/gallon in the US)."[19]

In brief, the proportions of new green vehicles in the California fleet do not match or exceed the level that the data and predictions used in the CARB methodology relied on for their standards.

[19] Graham, Michael. "U.S. Hybrid Car Sales in March... Not Good At All(April 2,2009), 1, http://www.treehugger.com/files/2009/04/us-hybrid-car-sales-down-44-percent-march-2009.php, (accessed April 18, 2009).

2. *RESEARCH METHODOLOGY*

2.1. RESEARCH DESIGN

This research examines the current greenhouse gas emissions standards of the California Air Resources Board with regard to light duty vehicles and examines its methodology in calculating and estimating the emissions reductions rates for motor vehicles as well as the off-shelf technology cost for emissions reducing packages based on assumed market and vehicle fleet information. This research also studies the effect of the 2007-2009 economic recession as it impacts and delays AB 1394 implementation. It asks the following questions:

- What are the obstacles to current GHG emissions standards with regard to their ability to fully meet and maintain the requirement and objective of the AB 1493 regulation?
    i. Why do these obstacles continue to stall effective implementation of the goals of AB 1493?
    ii. How do those obstacles relate to the current economic recession?
    iii. How can these obstacles be overcome?

- In what ways might the current economic crisis affect the ability of current GHG emissions standards to meet the requirements of AB 1493?

- What are the potential benefits of considering the effect of the recession as it pertains to the GHG standards methodology for calculating and estimating the emission rate and the cost off-shelf emissions reduction technology?
    i. Are there environmental benefits for California residents from automobile emissions reductions which factor in current economic conditions?
    ii. What are the economic benefits for reduced emissions during an economic downturn?

- What are the potential pitfalls?

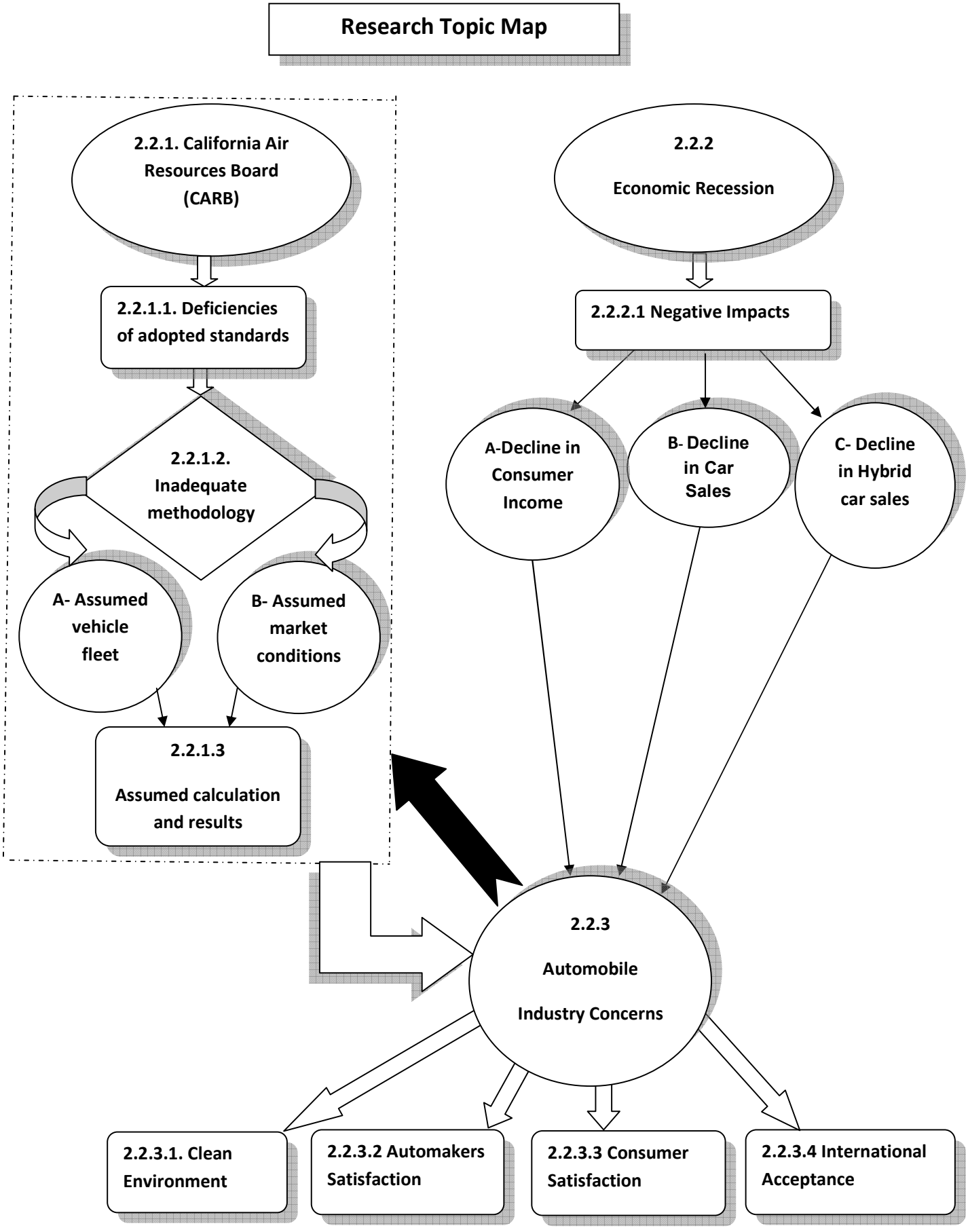
- To what extent does considering the economic recession impact contribute to successfully meeting and maintaining the requirements and objectives of the AB 1493 regulation?
    i. Will it serve to meet the intent of the regulation?
    ii. Will it fully guarantee that the CARB standards AB 1493 are met?

- To which extent does considering the impact of the economic recession contribute to successfully satisfying the California public's economic and environmental concerns as well as the automakers business concerns in light of GHG standards:
    i. Will it satisfy the needs of automobile manufacturers as a viable industry during a financial crisis?
    ii. Will it provide sufficient evidence that the environment is protected?
    iii. Will it satisfy the needs of low income consumers?

2.2. Research Topic Map

Research Topic Units and Aspects

The topic units and aspects of this research are mapped on the following page.
The four objectives of AB 1493 mapped here: a clean environment, automotive industry satisfaction, consumer satisfaction, and international acceptance of the standard. These objectives cannot be successfully met or maintained by CARB with currently proposed standards for one reason: the current standards are based on calculations of assumed vehicle fleet and assumed market conditions, which are wholly out of date and inaccurate when considering current recession conditions. The recession has caused a decline in consumer income, a decline in car sales, and especially in hybrid car sales. These economic pressures combined with a public which is more aware than ever about environmental issues will put pressure on the automakers, making them want to adopt emissions standards which reflect recession realities and consumer needs. Finally, the automotive industry must put pressure on CARB to adopt standards in line with their needs, and the two groups must work together in the end to achieve the goals set in AB 1493.


Research Topic Map
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2.2.3.3 Consumer Satisfaction
2.2.3.4 International Acceptance

Unit and Aspect

2.2.1. California Air Resource Board (CARB)

The California Air Resources Board is a part of the California Environmental Protection Agency, an organization which reports directly to the Governor's Office in the Executive Branch of California State Government.[20] The Mission of CARB is to promote and protect public health, welfare and ecological resources through the effective and efficient reduction of air pollutants while recognizing and considering the effects on the economy of the state.

The Major Goals of the Board are to:

Provide Safe, Clean Air to All Californians

- Protect the Public from Exposure to Toxic Air Contaminants
- Reduce California's emission of greenhouse gases
- Provide Leadership in Implementing and Enforcing Air Pollution Control Rules and Regulations
- Provide Innovative Approaches for Complying with Air Pollution Rules and Regulations
- Base Decisions on Best Possible Scientific and Economic Information
- Provide Quality Customer Service to All ARB Clients

2.2.1.2. Deficiencies of the adopted GHG standards.

Kenneth Johnson points out three main deficiencies the CARB GHG standards[21]

1. Incorrect calculation methodology.
2. LEV-compatibility constraints.
3. Conflicting policy objectives

2.2.1.3. Inadequate methodology

1. The methodology used by CARB to form GHG emissions reduction standards is inadequate because of changes in two sets of data:

A. Assumed Vehicles:

- CARB used data which described the 2002 fleet of light-duty vehicles and modeled their standards based on an unchanging 2002-styled fleet. The current California fleet is much different than in 2002 due in no small part to the current economic recession, so any standard extrapolated from a 2002 fleet would be inadequate.

B. Assumed Market:

[20] Cal/EPA, "California Air Resources Board Strategic Plan." 2000. http://www.arb.ca.gov/planning/plan01/planjan02.pdf(accessed April 1, 2009).

[21] Johnson, K. C., "California's greenhouse gas law, Assembly Bill 1493: Deficiencies, alternatives, and implications for regulatory climate policy". Energy Policy v. 35 no. 1 (January 2007) p. 362-72

- CARB also used economic data which described the California economy as a whole in 2002, including the assumption that average consumer incomes and average fuel prices would continue unchanged through 2016. These data do not in any way reflect current market and economic conditions, and therefore provide for a faulty emissions reduction model.

2.2.1.3. Assumed calculations and results

- The result of CARB's calculations is a standard based on data which has changed. The economic and vehicle fleet numbers from 2002 which are still used to calculate the proposed standards are incorrect under the extremely different conditions caused by today's recession. By using inaccurate and out-of-date numbers, CARB's conclusions can only be inadequate to meet their mission as described by AB 1493.

2.2.2. Economic Recession

- The Economic Outlook statement in the California Governor's Budget for the 2009-10 fiscal year contains a description of the state's struggling economy. The administration states that "The California Economy decelerated with the national economy" and cites the U.S. Commerce department's finding that total personal income grew less in the second half than in the first half of 2008. Real GDP and nonfarm payroll employment are falling, unemployment is rising over 5%, and consumer spending has dropped as well. On the whole, Californians have less money to spend on consumer goods such as new cars, especially those who find themselves suddenly unemployed or those who were already earning a low wage pre-recession.

2.2.2.1. Negative Impacts:

- The economic recession which began in 2007 and has continued through to the present has had a negative influence on three sectors of the California economy: Loss in average income for Californians, loss in sales for passenger cars and light duty trucks, and losses in sales of hybrid gas/electric (green) vehicles.

A. A Decline in Consumer Income:

According to governor Schwarzenegger's '09-'10 budget report, growth in consumer income has dropped precipitously, falling by 1.7 percent between 2008 and 2009.[22]

B. A Decline in Car Sales:

- The decline in car sales due to the recession fallout is made clear in a letter written by the California New Car Dealers Association to U.S. Treasury Secretary Timothy Geithner on 23 Feb. 2009 asking for federal economic assistance for its members, citing that "California new car dealers sold 433,570 fewer cars and trucks in 2008 than the year before (a 23% decline vs. 18% nationwide)."[23]

C. A Decline in Green Car Sales:

- In addition to the downward trend in total car sales, the L.A. Times reported on March 17th that hybrid car sales per month have dropped by over 15,000 gas/electric hybrids from December 2007 to February 2006.[24]
- CARB recommended a set of technologies that automakers could choose to reduce CO2 emissions from their new cars, thus implementing the new GHG standards. One of these technologies is the continuously variable transmission (CVT). CVT allows for an infinite number of gears and is usually operated by a belt or chain, similar to the way a bicycle transmission operates. The current economic recession is playing a significant role in undermining the sales of alternatively fueled or hybrid "green" cars, as.[25]

- The primary reason, of course, for this decrease in hybrid car sales in the U.S. is the current economic recession. This statement puts the cause in

[22] Governors'' Budget 2009-10, "Proposed Budget Summary Economic Outlook (2009), 1, http://www.ebudget.ca.gov/BudgetSummary/ECO/1249562.html, (accessed April 11, 2009).

[23] California New Car Dealers Association, CNDA. "Crisis In Dealer Floorplan Lending Will Exacerbate Job Loss(February 23, 2009), Page 1, http://cncda.org/resources/CNCDA_Letter_to_Mr_Geithner_2-23-2009.pdf, (accessed April 18 , 2009)

[24] Bensinger , Ken . "Hybrid car sales go from 60 to 0 at breakneck speed(March 17, 2009), Page 1, http://articles.latimes.com/2009/mar/17/business/fi-hybrid17, (accessed April 20, 2009).

[25] Richard, Michael Graham. "U.S. Hybrid Car Sales in March... Not Good At All (2009), http://www.treehugger.com/files/2009/04/us-hybrid-car-sales-down-44-percent-march-2009.php. (accessed April 16, 2009).

no uncertain terms: “It's the Economy, Stupid: the first, and biggest factor, is of course the economic recession. This has two effects on potential hybrid car buyers: 1) They have less money in their pockets, so might opt not to buy a car at all, or to buy a less expensive model, and 2) less economic activity = less demand for energy = lower oil prices (more or less), which makes fuel efficient hybrids seem like less of a good deal (unlike when gasoline was $4/gallon in the US).”[26]

- In brief, the proportions of new green vehicles in the California fleet do not match or exceed the level that the data and predictions used in the CARB methodology relied on for their standards. Thus, again the standards will prove to be inadequate.

2.2.3. Automobile Industry Concerns

- Producing cars with new emissions reducing technologies raises the manufacturers cost per unit built. In order for automakers to maintain and continue to grow their companies, they have no choice but to raise their prices to the consumer when producing cars outfitted to meet the new efficiency regulations. Manufacturers are concerned that this rise in prices coupled with the already present strain of an economy in recession on the Californian consumer will drive sales even lower than are right now, and threaten their ability to stay in business into the future. In brief, the automakers stand to lose the most from the new regulations, and therefore will exert the most pressure on CARB to influence any changes in emissions standards.

2.2.3.1. A Cleaner Environment

- If the decision were made by CARB to change the current GHG standards to reflect the current economic and social realities in light of this recession, then the objective of AB 1493 will be met, resulting in not only GHG emission reduction, but also providing a sustainable future and a model for other regulating bodies to adopt.

2.2.3.2. A Satisfied Auto Industry

- If the automaker’s concerns can be overcome in such a way that makes reducing emissions an advantage to their industry at a more appropriate and truly emissions reducing level than are already proposed, then they will naturally put pressure on CARB to adjust their regulations to a level which not only satisfies their own interests but also reduces emissions to the level directed by AB 1493.

2.2.3.3. Satisfied Consumer

[26] Graham, Michael . "U.S. Hybrid Car Sales in March... Not Good At All(april 2,2009), 1, http://www.treehugger.com/files/2009/04/us-hybrid-car-sales-down-44-percent-march-2009.php. (accessed April 18, 2009).

- A satisfied automaker creates a satisfied consumer. If the automaker is able to sell cars consumers want at prices that buyers are willing to pay during a recession, they will naturally buy more cars. If those cars are also more fuel efficient on the whole, then they will also benefit from the reduced operating costs of their more fuel efficient vehicles as well as from a sustainable environment.

2.2.3.4. An International Acceptance

- If California is able to work in concert with automakers to adequately and sustainably reduce emissions in an economy which is the fifth largest in the world, then this example will serve other states in the U.S. and other countries around the globe as they look for a solution to their own emissions regulation.

2.3. REASEARCH METHOD

The research method of this paper is unique: the GHG emission standard was recalculated by the same methodology employed by CARB in setting the GHG emission standard, but instead of using 2002-model vehicle fleet data, the actual 2009-model vehicle fleet data was used in order to draw a final conclusion comparing the new results of the GHG emission standard (applying 2009 data) with the current GHG emission standard (2002 data). The main purpose of this comparison method is to determine if there are any differences between the proposed GHG Emission standard by CARB, and the new GHG Emission Standard of this research paper. Also if these differences, if any, are a result of the recent economic recession hitting California state impacting auto market. However, the boundary of this research for calculating the new GHG emission standard was only covering the first vehicle's class, (''PC/LDT1'') comprises passenger cars up to 6000 lb. and light-duty trucks up to 3750 lb. for the year of 2009. The primary reason behind choosing the year of 2009 and no other years is because the availability of the actual 2009-model vehicles fleet data. This due to the fact that there were no enough data for the other vehicles class, the second class (''LDT2'') comprises light-duty trucks exceeding 3750 lb.

CARB's Methodology

Kenneth Johnson has summarized the methodology of CARB as follow:

"The standard is based on an engineering study of five representative vehicles selected from the model-year 2002 new vehicle fleet. These vehicles' feasible emission levels were determined by engineering simulation and cost analysis, and were extrapolated to construct a parametric model representing the feasible emission level for all light-duty vehicles. The most significant emissions-related vehicle characteristic is weight so the feasible emission level was parameterized as a function of ''test weight'' (i.e., the loaded vehicle weight at which emissions performance is tested). The emission standard was intended to be incorporated into the LEV program, so separate functions were defined for the two LEV vehicle classes. The first class (''PC/LDT1'') comprises passenger cars up to 6000 lb. and light-duty trucks up to 3750 lb., and the second class (''LDT2'') comprises light-duty trucks exceeding 3750 lb. (The ''truck'' categories include SUVs and minivans. For California, model-year 2002, the LDT2 category comprised 46% of the major manufacturers' vehicle fleets and accounted for 54% of their emissions.) The five representative vehicles' feasible emission levels are plotted against test weight in Figure 2.3. The vertical scale in the figure represents CO2-equivalent GHG emissions in gram-per mile (g/mi) units. The plotted emission levels are actually slightly below the calculated feasibility limit because of the way the regulations handle air conditioning emissions. Vehicle emissions performance is tested without air conditioning, but manufacturers are encouraged to comply with recommended practices for controlling air conditioning emissions. Those who demonstrate compliance will be granted a compensating allowance of emission credits. The emission levels represented in Figure 2.3, when incremented by the air conditioning credit, equate to the actual estimated feasible emission level. 27

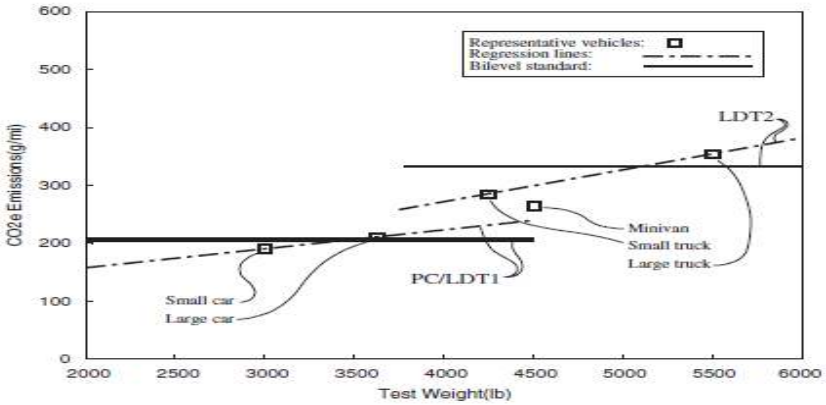


Figure 2.3.: Methodology of standard determination

[27] Johnson, K. C., "California's greenhouse gas law, Assembly Bill 1493: Deficiencies, alternatives, and implications for regulatory climate policy". Energy Policy v. 35 no. 1 (January 2007) p. 362-72

The feasible emission level, as a function of arbitrary vehicle weight, was defined by linearly extrapolating from the ‘‘small car’’ and ‘‘large car’’ data points for the PC/LDT1 category, and by linearly extrapolating from the ‘‘small truck’’ and ‘‘large truck’’ points for the LDT2 category. These extrapolations, termed ‘‘regression lines’’, are illustrated in Figure 2.3. The ‘‘minivan’’ data point was neglected in defining the regression lines because even though the LEV classification places minivans in the LDT2 category, ‘‘these vehicles are generally based on a passenger car chassis and their CO2 emissions are more properly aligned with passenger cars than trucks’’. The regression lines represent CARB’s best estimate of ‘‘the maximum feasible reduction levels’’, and cost-effectiveness is implicit in this characterization. According to this characterization, the regression lines represent the ‘‘maximum feasible and cost-effective’’ reduction level specified by the AB 1493 mandate; hence, the regression lines define an emission standard that would satisfy the mandate. However, this is not the standard that was adopted. Instead, each regression line was converted to a flat, weight-independent emission limit defined by a sales average of the regression line for each LEV class, and the standard defined by these two emission limits is what was adopted. The sales average was computed based on General Motors’ model-year 2002 California sales fleet. The choice of GM as the standard-setting manufacturer was intended to ensure that the standard would be feasible and cost effective for all six major manufacturers (Daimler Chrysler, Ford, General Motors, Honda, Nissan, and Toyota) without relying on emissions trading between manufacturers. The standard is to be phased in over an 8-year period between 2009 and 2016. ”

3. *Calculations*

In this section, the resrecher conduts the following steps:

1- Analyzing the proposed GHG emission standrd by CARB for the PCT1 vehicale Class
2- Calculating the actual-2009 GHG emission standards for PCT1 vehicale class using CARB methdology
3- Copmaring the GHG emission standard for PCT1 vehicale class from both step one and step two.

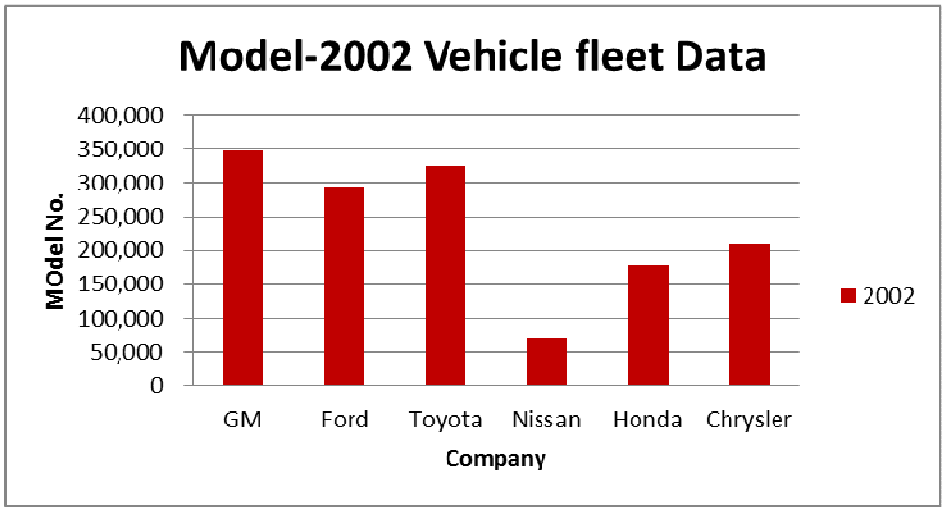
3.1. *The proposed GHG emission standard by CRAB (using 2002 vehicle fleet data) for PCT1 vehicle class.*

Before discussing the Proposed GHG Emission standard by CARB, the model-2002 vehicle fleet data should be represented here becuase CARB used it as based data in finalizing the propsed standard. The model-2002 vehicle fleet data are represented in Table 3.1

Year/ Automakers	GM	Ford	Toyota	Nissan	Honda	Chrysler	Total
2002	347.379	294.168	325.638	70.014	178.785	209.747	1,425,731

Table 3.1: , the Model-2002 Vehicle Fleet Data

The information of table 3.1 represent the total number of sold cars by each six major company in 2020. Also it represnt the total number of sold cars for the six major auto companies toghether. The total number of sold for all six major companies together is 1,425,731. However, looking at Figure 3.1 is is obvious that General Motor had the highest number of sold cars in california in 2002.



Fuguare 3.1: Model-2002 Vehicle Fleet Data

Aftre introducing the Model-2002 Vehicle Fleet Data, the next step would be identifying the boundry of this research paper. As mentinoed in background section of this paper, the proposed GHG Emission Standard were setted by CARB in 2002 to cover two vehicle"s classes. The first class is PC/LDT1 which comprises passenger cars up to 6000 lb and light-duty trucks up to 3750 lb, and the second class is LDT2 which comprises light-duty trucks exceeding 3750 lb. In addition, The standard is to be phased in over an 8-year period between 2009 and 2016. However, The aboundry of this reserch paper would be focusing on the first vehicle class , PCT!/LDT1. Also it will be covering the first year of 8-year period which is the year of 2009. Thus , the whole calculation of this section will be condusted for PCT1 vehicles, and for the year of 2009. This decison was made becuase the whole fleet data of PCT1 vehicle in 2009 is avilable. Also becuase the PCT1 category comprised 54% of the major californian manufacturers' vehicle fleets in, and accounted for 46% of their emissions.

Tier	Year	CO_2-equivalent emission standard by vehicle category (g/mi)	
		PC/LDT1	LDT2
Near-term	2009	323	439
	2010	301	420
	2011	267	390
	2012	233	361
	2013	227	355
Mid-term	2014	222	350
	2015	213	341
	2016	205	332

Table 3.1.1: CO2 Equivalent Emission Standard for Model Years 2009 through 2016

From Table 3.1.1 the CO2 equivalent emission standard for PCT1/LDT1 Ccategory is 323 (g/mi). The 323 (g/mi) is the prposed GHG emission standar by California Air Resource Borad for all the six amjor auto companies: GM, Ford, Toyota, Honda, Crysler, and Nissan.

How does CARB calculate the 323 (g/mi)?

CARB staff used thier methdology to calculate the GHG emission standard for each of the six major companies as follow:

A- General Motor Company

TW	Model Name	Model No.	Veh Class	CID	Disp (L)	MPG	CO2	TW	CW	tw*num	CO2*num
2750	PRIZM	1527	Sub Compact	110	1,8	36,0	247	2750	2450	4199250	377508,3333
2750	SC1	3657	Sub Compact	116	1,9	34,4	259	2750	2454	10056750	946142,4419
2750	SL	1902	Compact	116	1,9	36,2	246	2750	2454	5230500	467296,0663
2750	SL1	3924	Compact	116	1,9	36,1	247	2750	2454	10791000	967412,7424
2750	SL2	7369	Compact	116	1,9	34,0	262	2750	2454	20264750	1928944,118
3000	CAVALIER	6068	Compact	133	2,2	31,6	281	3000	2707	18204000	1706713,952
3000	SUNFIRE	2899	Compact	133	2,2	30,2	295	3000	2707	8697000	854341,0596
3125	CAVALIER	246	Compact	146	2,4	27,7	321	3125	2847	768750	78980,88403
3125	SUNFIRE	92	Compact	146	2,4	27,5	324	3125	2847	287500	29774,54545
3375	ALERO	2641	Compact	134	2,2	24,6	362	3375	3075	8913375	955483,7398
3375	ALERO	4441	Compact	204	3,3	29,3	304	3375	3075	14988375	1348972,696
3375	GRAND AM	6437	Compact	134	2,2	27,7	321	3375	3075	21724875	2068205,776
3375	L100	2316	Midsize	134	2,2	29,0	307	3375	3068	7816500	710772,4138
3375	L200	4173	Midsize	134	2,2	29,0	307	3375	3068	14083875	1280679,31
3375	LW200	708	Midsize	134	2,2	29,6	301	3375	3075	2389500	212878,3784
3375	MALIBU	9941	Midsize	191	3,1	28,1	317	3375	3075	33550875	3148572,954
3375	TRACKER	797	Small SUV	122	2,0	29,5	302	3375	3075	2689875	240613,9756
3500	93	1677	Midsize	121	2,0	29,5	302	3500	3200	5869500	506801,3582
3500	93	70	Midsize	140	2,3	28,0	318	3500	3200	245000	22250
3500	CORVETTE	4632	Two Seater	350	5,7	24,6	362	3500	3200	16212000	1675804,878
3500	GRAND AM	4008	Compact	204	3,3	29,3	304	3500	3200	14028000	1217447,099
3500	L300	2484	Midsize	183	3,0	27,6	322	3500	3200	8694000	801000
3500	SONOMA	865	Small PU	133	2,2	26,3	338	3500	3256	3027500	292718,6312
3500	S10	3153	Small PU	133	2,2	26,3	338	3500	3248	11035500	1066984,791
3500	TRACKER	808	Small SUV	152	2,5	22,7	391	3500	3200	2828000	316328,4457
3500	VUE	1215	Small SUV	138	2,3	30,1	296	3500	3200	4252500	359252,4917
3625	CENTURY	12124	Midsize	191	3,1	28,1	317	3625	3341	43949500	3839985,765
3625	GRAND PRIX	6370	Midsize	191	3,1	28,1	317	3625	3325	23091250	2017544,484
3625	LW300	795	Midsize	183	3,0	27,6	322	3625	3325	2881875	256358,6957
3625	MONTE CARLO	1084	Midsize	204	3,3	29,3	304	3625	3325	3929500	329269,6246
3750	CAMARO	1562	Sub-Compact	231	3,8	26,9	331	3750	3485	5857500	516795,539
3750	CAMARO	3016	Sub-Compact	350	5,7	24,5	363	3750	3467	11310000	1096289,133
3750	GRAND PRIX	2281	Midsize	231	3,8	25,7	347	3750	3450	8553750	791458,0897
3750	IMPALA	6074	Large Car	204	3,3	29,3	304	3750	3450	22777500	1845003,413
3750	IMPALA	3366	Large Car	231	3,8	25,7	347	3750	3465	12622500	1167929,825
3750	INTRIGUE	988	Midsize	211	3,5	27,7	321	3750	3450	3705000	317444,0433
3750	MONTE CARLO	2005	Midsize	231	3,8	26,6	335	3750	3450	7518750	670845,8647
3750	REGAL	3507	Midsize	231	3,8	25,6	348	3750	3450	13151250	1219230,469
3875	9/5	323	Midsize	140	2,3	26,5	336	3875	3575	1251625	108479,2453
3875	FIREBIRD	601	Sub Compact	231	3,8	26,9	331	3875	3575	2328875	198843,8662
3875	FIREBIRD	1228	Sub Compact	350	5,7	24,6	363	3875	3575	4758500	445181,2627
3875	LESABRE	6651	Large Car	231	3,8	26,6	335	3875	3575	25772625	2225334,586
4000	AURORA	593	Midsize	211	3,5	24,6	362	4000	3700	2372000	214540,6504
4000	AURORA	75	Midsize	244	4,0	23,5	379	4000	3700	300000	28404,25532
4000	BONNEVILLE	1829	Large Car	231	3,8	26,4	338	4000	3700	7316000	617751,5178

Table 3.1.2: GM model-2002 PCT1 vehicle fleet information

TW*num = TW * Model No. , TW : Test Wieght
CO2*num = CO2 * Model No. , CO2 : the value of CO2

CARB staff then calculate the GHG Emission Standard for General motor company using the following equations;

Equation 1;
CO2 (g/mi) = sum of CO2*num / sum of Model No. = 44280023,53 / 140300 = 315,6095761 ≈ **316**

Equation 2:
Test Wieght = sum of TW*num / sum of Model No. = 486833000/ 140300 = 3469,942979 ≈ **3470**

Thus the final GHG emission standard for General Motor company is summurized in the following table :

Value / Vehicale class	pct1
Model No.	140.300
test weight	3470
CO2 (g/mi)	316

B- Nissan Company

TW	Model Name	Model No.	CID	Disp (L)	MPG	CO2	TW	CW	tw*num	CO2*num
3000	SENTRA	13838	108	1,8	35,1	253	3000	2667	41514000	3507543
3250	G20	2752	122	2,0	31,0	287	3250	3036	8944000	790090,32
3375	ALTIMA	9305		2,5	29,5	301	3375	3072	31404375	2802879
3625	FRONTIER	6287	146	2,4	26,2	339	3625	3325	22790375	2133152,9
3625	MAXIMA	6543	214	3,5	26,0	343	3625	3320	23718375	2243962,7
3625	ALTIMA	2962	213	3,5	25,3	351	3625	3316	10738990	1040635,8
4250	Q45	1515	274	4,5	23,3	382	4250	3942	6438750	578690,99

Table 3.1.3: Nissan model-2002 PCT1 vehicle fleet information

Using the both equation 1 & 2 , the final GHG emission standard for NISSAN company is summurized in the following table :

Value / Vehicale class	PCT1
number	43.202
test weight	3369
CO2 (g/mi)	303

C- HONDA company

TW	Model Name	Model No.	CID	Disp (L)	MPG	CO2	TW	CW	tw*num	CO2*num
2125	INSIGHT	183	061	1,0	69,2	129	2125	1887	388875	23527,23
2875	CIVIC	54816	102	1,7	39,3	226	2875	2512	157596000	12411351
2875	CIVIC	1081	122	2,0	32,4	275	2875	2555	3107875	296941,4
3000	RSX	8889	122	2,0	32,5	274	3000	2636	26667000	2433755
3125	S2000	1801	122	2,0	26,6	335	3125	2844	5628125	602590,2
3375	ACCORD	28873	138	2,3	30,2	295	3375	3109	97446375	8518372
3500	NSX	1	182	3,0	22,9	389	3500	3164	3500	388,6463
3500	NSX	40	194	3,2	22,6	394	3500	3164	140000	15752,21
3500	CR-V	18570	146	2,4	28,2	315	3500	3200	64995000	5858107
3625	ACCORD	20988	183	3,0	27	330	3625	3329	76081500	6918267
3750	3.2CL	844	197	3,2	26,7	333	3750	3461	3165000	281333,3
3750	3.2TL	10323	197	3,2	26,7	333	3750	3461	38711250	3441000
4250	3.5RL	1536	212	3,5	23,5	379	4250	3880	6528000	581719,1

Table 3.1.4: HONDA model-2002 PCT1 vehicle fleet information

The final GHG emission standard for NISSAN company is summurized in the following table:

Value / Vehicale class	PCT1
number	147.945
test weight	3248
CO2 (g/mi)	280

D- TOYOTA Company

TW	Model Name	Model No.	CID	Disp (L)	MPG	CO2	TW	CW	tw*num	CO2*num
2500	ECHO	5039	091	1,5	41,3	215	2500	2200	12597500	1085622
2625	MR2	1188	109	1,8	31,8	280	2625	2325	3118500	332490,6
2875	CELICA	4736	110	1,8	35,2	253	2875	2575	13616000	1196448
2875	COROLLA (U.S.)	27299	109	1,8	38,5	231	2875	2575	78484625	6314323
3125	PRIUS	2585	91	1,5	57,6	155	3125	2825	8078125	399418,4
3250	RAV4	14907	122	2,0	29,5	302	3250	2950	48447750	4500005
3375	TACOMA	11643	149	2,4	27,6	323	3375	3075	39295125	3758389
3500	CAMRY	51629	144	2,4	31,1	286	3500	3200	180701500	14760575
3500	CAMRY SOLARA	2808	144	2,4	30,8	289	3500	3200	9828000	810969,8
3625	CAMRY SOLARA	3786	183	3,0	26,0	342	3625	3352	13724250	1295522
3750	ES300	13198	183	3,0	27,8	320	3750	3450	49492500	4225259
3750	AVALON	10130	183	3,0	26,9	331	3750	3450	37987500	3351561
3750	CAMRY	19326	183	3,0	26,0	342	3750	3450	72472500	6613114
3875	IS300	7804	183	3,0	23,7	376	3875	3575	30240500	2930616
4000	GS300	3744	183	3,0	24,3	366	4000	3700	14976000	1371259
4250	GS430	754	262	4,3	23,4	380	4250	3950	3204500	286777,8
4250	LS430	5480	262	4,3	24,2	368	4250	3950	23290000	2015372
4250	SC430	5823	262	4,3	23,4	380	4250	3950	24747750	2214731

Table 3.1.25: TOYOTA model-2002 PCT1 vehicle fleet information

The final GHG emission standard for TOYOTA company is summurized in the following table:

Value / Vehicale class	PCT1
number	191.879
test weight	3462
CO2 (g/mi)	299

E- FORD Company

TW	Model Name	CountOfModel Name	CID	Disp (L)	MPG	CO2	TW	CW	tw*num	CO2*num
2875	ESCORT	9377	122	2,0	33,6	265	2875	2537	26958875	2485721
3000	FOCUS	18512	122	2,0	35,4	251	3000	2693	55536000	4652741
3375	ESCAPE	575	121	2,0	28,4	314	3375	3075	1940625	180476,8
3375	RANGER	5664	140	2,3	28,9	308	3375	3075	19116000	1744406
3375	COUGAR	93	121	2,0	31,7	281	3375	3107	313875	26110,41
3375	S40	2379	119	2,0	28,7	310	3375	3068	8029125	737738,7
3375	V40	646	119	2,0	28,7	310	3375	3118	2180250	200327,5
3500	MUSTANG	16296	232	3,8	25,9	343	3500	3142	57036000	5595025
3625	MUSTANG	6751	281	4,6	24,0	371	3625	3364	24472375	2503914
3625	TAURUS	23400	182	3,0	26,6	335	3625	3379	84825000	7830951
3625	SABLE	1629	182	3,0	26,5	335	3625	3373	5905125	546136
3625	S60	4547	149	2,4	27,9	319	3625	3342	16482875	1450903
3625	S80	1509	178	2,9	24,7	360	3625	3379	5470125	542656,9
3750	C70	441	142	2,3	24,9	357	3750	3490	1653750	157464,1
3750	S60	403	142	2,3	27,4	325	3750	3444	1511250	131128,6
3750	ESCAPE	13250	181	3,0	24,2	368	3750	3450	49687500	4875889
3875	V70	305	142	2,3	26,0	343	3875	3635	1181875	104595,5
4000	THUNDERBIRD	2979	240	3,9	22,5	396	4000	3762	11916000	1178360
4000	S-TYPE	1261	181	3,0	23,9	372	4000	3816	5044000	469577,4
4000	LS	1463	182	3,0	24,0	372	4000	3705	5852000	543560,5
4000	LS	2695	240	3,9	22,5	396	4000	3803	10780000	1066022
4000	C70	122	149	2,4	26,0	342	4000	3700	488000	41761,54
4000	V70	3145	149	2,4	23,5	378	4000	3700	12580000	1189224
4250	CROWN VICTORIA	2919	281	4,6	23,8	374	4250	3973	12405750	1091559
4250	S-TYPE	680	244	4,0	23,2	384	4250	3903	2890000	260862,1
4250	VDP	251	244	4,0	22,9	389	4250	4010	1066750	97550,22
4250	XJ	476	244	4,0	22,9	389	4250	3946	2023000	184995,6
4250	XJ SPORT	515	244	4,0	22,9	389	4250	3988	2188750	200152,8
4250	XJR	195	244	4,0	21,3	418	4250	4050	828750	81478,87
4250	XK8	466	244	4,0	22,9	389	4250	3962	1980500	181109,2
4250	CONTINENTAL	626	281	4,6	23,4	380	4250	3908	2660500	238094
4250	MARQUIS	4112	281	4,6	23,8	374	4250	3988	17476000	1537681
4500	TOWN CAR	2889	281	4,6	22,4	397	4500	4135	13000500	1147862

Table 3.1.6: FORD model-2002 PCT1 vehicle fleet information

The final GHG emission standard for FORD company is summurized in the following table:

Value / Vehicale class	PCT1
number	130.819
test weight	3569
CO2 (g/mi)	332

F- CRYSLER Company

TW	Model Name	CountOfModel Name	CID	Disp (L)	MPG	CO2	TW	CW	tw*num	CO2*num
3000	NEON	6085	122	2,0	32,2	277	3000	2714	18255000	1684013
3125	PROWLER	169	215	3,5	23,1	385	3125	2861	528125	65112,55
3375	SEBRING	72	143	2,3	27,6	322	3375	3115	243000	23217,39
3375	SLK230	723	140	2,3	28,8	309	3375	3102	2440125	223684,7
3500	SEBRING	1878	148	2,4	28,3	314	3500	3242	6573000	590607,8
3500	STRATUS	3317	148	2,4	28,3	315	3500	3215	11609500	1044994
3500	WRANGLER/TJ	691	150	2,5	21,9	407	3500	3222	2418500	281257,7
3500	SLK320	854	195	3,2	26,2	340	3500	3150	2989000	289998
3625	PT CRUISER	24226	148	2,4	25,5	349	3625	3287	87819250	8459329
3625	SEBRING	7183	167	2,7	26,2	340	3625	3313	26038375	2442450
3625	SEBRING	640	181	3,0	26,6	335	3625	3283	2320000	214219,2
3625	STRATUS	638	167	2,7	26,2	340	3625	3276	2312750	216718,1
3625	STRATUS	526	181	3,0	26,6	334	3625	3260	1906750	175710,7
3625	CLK320	2768	195	3,2	26,0	343	3625	3316	10034000	949135,1
3625	E320	6147	195	3,2	25,1	355	3625	3316	22282875	2179614
3750	CONCORDE	714	167	2,7	26,6	335	3750	3501	2677500	238894,7
3750	INTREPID	10053	167	2,7	26,6	335	3750	3484	37698750	3363598
3750	VIPER	65	488	8,0	16,4	543	3750	3479	243750	35274,39
3750	C240	9771	158	2,6	24,3	366	3750	3415	36641250	3578679
3875	CHRYSLER 300M	2739	215	3,5	24,4	365	3875	3622	10613625	999061,5
3875	CONCORDE	798	215	3,5	24,7	360	3875	3602	3092250	287538,5
3875	INTREPID	1535	215	3,5	24,7	361	3875	3611	5948125	553492,6
3875	C320	4758	195	3,2	25,6	348	3875	3439	18437250	1654148
4000	CLK430	2234	260	4,3	23,6	377	4000	3768	8936000	842483,1
4000	E430	1431	260	4,3	23,3	382	4000	3757	5724000	546605,2
4000	E55	332	332	5,4	22,2	401	4000	3768	1328000	133099,1
4000	S55AMG	395	332	5,4	22,2	401	4000	3710	1580000	158355,9

Table 3.1.7: Crysler model-2002 PCT1 vehicle fleet information

The final GHG emission standard for CRYSLER company is summurized in the following table:

Value / Vehicale class	PCT1
number	90.742
test weight	3644
CO2 (g/mi)	344

The 2002 Baseline CO2 Equivalent Emissions and Test Weight by Manufacturer is represented in the following table ;

Value / Company	GM	FORD	CRYSLER	TOYOTA	HONDA	NISSAN
MODEL No.	140.300	130.819	90742	191879	147945	43202
Test Weight	3470	3569	3644	3462	3248	3369
CO2 (g/mi)	316	332	344	299	280	303

Table 3.1.8: The 2002 Baseline CO2 Equivalent Emissions and Test Weight by Manufacturer for PCT1 category

3.2. The Actual GHG emission standard of this paper (using the actual model-2009 vehicle fleet data) for PCT1 vehicle class.

The model-2009 vehicle fleet data was extracted from California Auto Outlook, Comprehensive information on the California new vehicle market, that was published in January 2010 by CNCDA (California New Car Dealers Association). The fleet data is detialed in table 3.2.

Ford		Honda		GM		Chrysler		Toyota		Nissan	
Model	No.	Model	No.	Model	No.	Model	No.	Model	No.	Model	No.
Ford	110.717	Honda	127.110	Buick	4.554	Chrysler	13.380	Toyota/Scion	215.248	Nissan	70.198
Lincoln	5.326	Acura	13.555	Cadillac	7.902	Dodge	29.883	Lexus	39.595	Infiniti	11.773
Mercury	5.746			Chevrolet	78.575	Jeep	12.478				
Volvo	6.498			GMC	15.138	Mercedes	41.766				
Jaguar	2.724			Hummer	579						
Land Rover	4.642			Saturn	5.267						
				Pontiac	8.981						
Total	**135.653**		**140.665**		**120.996**		**97.507**		**254.843**		**81.971**

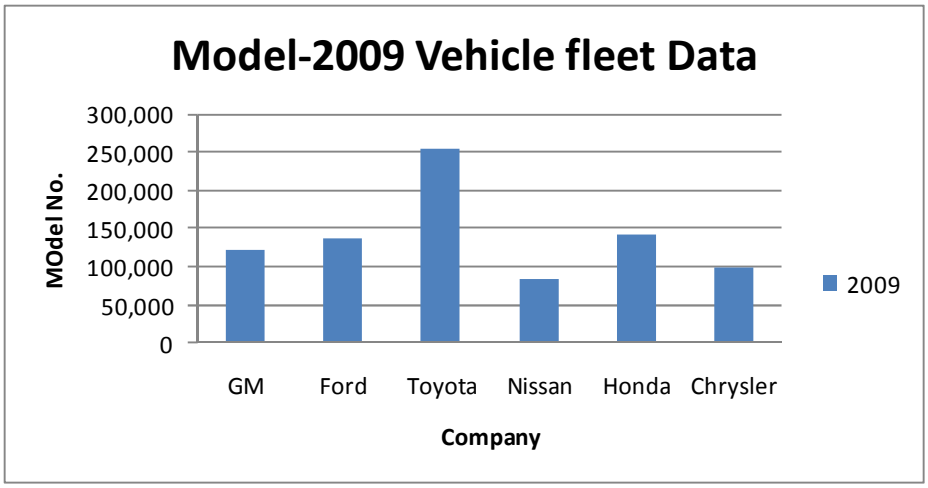
Table 3.2: The Model-2009 fleet data

Notice that the information in table 3.2 represent both the PCT1/LDT1 and LDT2 Category. Moreover, the model-2009 vehicle fleet data can be summrized in the table 3.2.1:

Year/ Automakers	GM	Ford	Toyota	Nissan	Honda	Chrysler	Total
2009	120.996	135.653	254.843	81.971	140.665	97.507	831.635

Table 3.2.1: the Model-2009 Vehicle Fleet Data

The information from table 3.2.1 are plotted in figure 3.2.1. From the figure, TOYOTA company had the highest number of sold cars in 2009. In contrast, The lowest was for NISSAN.



Figuare 3.2.1: the Model-2009 Vehicle Fleet Data

The next step is to calculate the actual 2009 GHG emission Standard for PCT1 vehicle by using the same methdology that CARB utalized in setting the proposed standard. To do so, the actual model-2009 vehicale fleet model that was published by CNCDA should be used in order to come up with the actual 2009 GHG emission standard.. However, The methdology of CARB was designed based on the model-2002 vehicle fleet data, and the researcher has dicover an inconsisincy in infromation between the model-2002, and 2009 vehicle fleet. The inconsisincy was that there were missing PCT1/LDT1 model names and specifiction (in the model-2009 vehicle fleet) that were exsist in the model-2002 vehicle fleet or vice versa. This could be a real chalange becuase this inconsinty would make the calculation more difficult or mostly impossible. To solve this problem, sampling techniques were used in ordere to a void mentioned problem. The researcher, however, has selected only the same PCT1/LDT1 model names that exsist in both the model-2002, and 2009 vehicle fleet data. This step would allow the resercher to easily calculate the actual 2009 GHG emission standard for PCT1/LDT1 category.

The selected vehicle models that are exsisted in both of model-2009 and 2002 are represented in the table;

	Auto Company					
Model Name	GM	Ford	Toyota	Nissan	Honda	Chrysler
	MALIBU	ESCAPE	COROLLA (U.S.)	SENTRA	ACCORD	WRANGLER/TJ
	CORVETTE	RANGER	PRIUS	G20	CR-V	CHRYSLER 300M
	IMPALA	MUSTANG	AVALON	FRONTIER		
				MAXIMA		
				ALTIMA		

Table 3.2.2: Selected PCT1/LDT1 model names

Based on the above sellected model names, The next step would be calculating the actual 2009 GHG emission standard for PCT1/LDT1 category fro each six major companies using the CARB methdology as follow:

A. General Motor Company

General company has only three selected models which are MALIBU, CORVETTE and IMPALA, and as assumed before they have the same test weight result. Thus table 3.2.3 represents the model number and the amount of CO2 for each model.

TW	Model Name	Model No.	Veh Class	CID	Disp (L)	MPG	CO2	TW	CW	tw*num	CO2*num
3375	MALIBU	4569	Midsize	191	3,1	28,1	317	3375	3075	15420375	1447121
3500	CORVETTE	1267	Two Seater	350	5,7	24,6	362	3500	3200	4434500	458386,2
3750	IMPALA	1324	Large Car	204	3,3	29,3	304	3750	3450	4965000	402170,6

Table 3.2.2: GM Selected PCT1/LDT1 model names, and their test weight result

By using the same equation of number 1 & 2 that were used in CARB methdology, the actual GHG emission can be calculated as follow:

Equation 1;

CO2 (g/mi) = sum of CO2*num / sum of Model No. = 2307677,824/ 7160 = 322,301372≈ 322

Equation 2;

Test Wieght = sum of TW*num / sum of Model No. = 24819875/ 7160 = 3466,462989≈ 3470

thus the final GHG emission standard for General Motor company is summurized in the following table :

Value / Vehicale class	pct1
number	7160
test weight	3466
CO2 (g/mi)	322

B. FORD

TW	Model Name	CountOfModel Name	CID	Disp (L)	MPG	CO2	TW	CW	tw*num	CO2*num
3375	ESCAPE	8142	121	2,0	28,4	314	3375	3075	27479250	2555552
3375	RANGER	4706	140	2,3	28,9	308	3375	3075	15882750	1449360
3500	MUSTANG	4745	232	3,8	25,9	343	3500	3142	16607500	1629136

Table 3.2.3: FORD Selected PCT1/LDT1 model names, and their test weight result

Using the same equation of 1& 2, the final GHG emission standard would be as follow:

Value / Vehicale class	pct1
number	17593
test weight	3409
CO2 (g/mi)	320

C. TOYOTA

TW	Model Name	Model No	CID	Disp (L)	MPG	CO2	TW	CW	tw*num	CO2*num
2875	COROLLA (U.S.)	35478	109	1,8	38,5	231	2875	2575	101999250	8206144
3125	PRIUS	26420	91	1,5	57,6	155	3125	2825	82562500	4082257
3750	AVALON	1623	183	3,0	26,9	331	3750	3450	6086250	536977,7

Table 3.2.4: TOYOTA Selected PCT1/LDT1 model names, and their test weight result

Value / Vehicale class	pct1
number	63521
test weight	3001
CO2 (g/mi)	202

D. HONDA

TW	Model Name	Model No	CID	Disp (L)	MPG	CO2	TW	CW	class	tw*num	CO2*num
2125	INSIGHT	2756	061	1,0	69,2	129	2125	1887	PCT1	5856500	354322,6
2875	CIVIC	36351	102	1,7	39,3	226	2875	2512	PCT1	1,05E+08	8230535
3375	ACCORD	32718	138	2,3	30,2	295	3375	3109	PCT1	1,1E+08	9652759
3500	CR-V	19684	146	2,4	28,2	315	3500	3200	PCT1	68894000	6209530

Table 3.2.5: TOYOTA Selected PCT1/LDT1 model names, and their test weight result

Value / Vehicale class	pct1
number	91509
test weight	3166
CO2 (g/mi)	267

E. NISSAN

TW	Model Name	Model No	CID	Disp (L)	MPG	CO2	TW	CW	class	tw*num	CO2*num
3000	SENTRA	13838	108	1,8	35,1	253	3000	2667	PCT1	41514000	3507543
3250	G20	6042	122	2,0	31,0	287	3250	3036	PCT1	19636500	1734639
3625	FRONTIER	2433	146	2,4	26,2	339	3625	3325	PCT1	8819625	825506,8
3625	MAXIMA	2424	214	3,5	26,0	343	3625	3320	PCT1	8787000	831325,9
3625	ALTIMA	14395	213	3,5	25,3	351	3625	3316	PCT1	52181875	5056558

Table 3.2.6: NISSAN Selected PCT1/LDT1 model names, and their test weight result

Value / Vehicale class	pct1
number	39132
test weight	3346
CO2 (g/mi)	306

F. CRYSLER

TW	Model Name	Model No	CID	Disp (L)	MPG	CO2	TW	CW	class	tw*num	CO2*num
3500	WRANGLER/TJ	4811	150	2,5	21,9	407	3500	3222	PCT1	16838500	1958221
3875	CHRYSLER 300M	2258	215	3,5	24,4	365	3875	3622	PCT1	8749750	823614,8

Table 3.2.7: CRYSLER Selected PCT1/LDT1 model names, and their test weight result

Value / Vehicale class	pct1
number	7069
test weight	3620
CO2 (g/mi)	394

The 2009 Baseline CO2 Equivalent Emissions and Test Weight for PCT1/LDT1 category by Manufacturer is represented in the table 2.2.8

Value / Company	GM	FORD	CRYSLER	TOYOTA	HONDA	NISSAN
MODEL No.	**7160**	**17593**	**7069**	**63521**	**91509**	**39132**
Test Weight	**3466**	**3409**	**3620**	**3001**	**3166**	**3346**
CO2 (g/mi)	**322**	**320**	**394**	**202**	**267**	**306**

Table 3.2.8: The 2009 Baseline CO2 Equivalent Emissions and Test Weight for PCT1/LDT1 category by Manufacturer

3.3. Comparing both the Actual 2009 GHG emission standard(based on model-2009 vehicle fleet data) with The proposed GHG emission standard by CARB (based on model-2002 vehicle fleet data)

In order to compaire the Actual GHG emission standard(based on model-2009 vehicle fleet data) with the propsed GHG emission standard by CARB (based on model-2002 vehicle fleet data) , the compariosn method should be applied on each six major company with same selected PCT1/LDT1 vehicle class as follow:

A- General Motor

2002												
TW	Model Name	fModel No	Veh Class	CID	Disp (L)	MPG	CO2	TW	CW	class	tw*num	CO2*num
3375	MALIBU	9941	Midsize	191	3,1	28,1	317	3375	3075	PCT1	33550875	3148573
3500	CORVETTE	4632	Two Seater	350	5,7	24,6	362	3500	3200	PCT1	16212000	1675805
3750	IMPALA	6074	Large Car	204	3,3	29,3	304	3750	3450	PCT1	22777500	1845003

2009												
TW	Model Name	Model No	Veh Class	CID	Disp (L)	MPG	CO2	TW	CW	class	tw*num	CO2*num
3375	MALIBU	4569	Midsize	191	3,1	28,1	317	3375	3075	PCT1	15420375	1447121
3500	CORVETTE	1267	Two Seater	350	5,7	24,6	362	3500	3200	PCT1	4434500	458386,2
3750	IMPALA	1324	Large Car	204	3,3	29,3	304	3750	3450	PCT1	4965000	402170,6

2002	
Value / Vehicale class	pct1
number	20647
test weight	3513
CO2 (g/mi)	323

2009	
Value / Vehicale class	pct1
number	7160
test weight	3466
CO2 (g/mi)	322

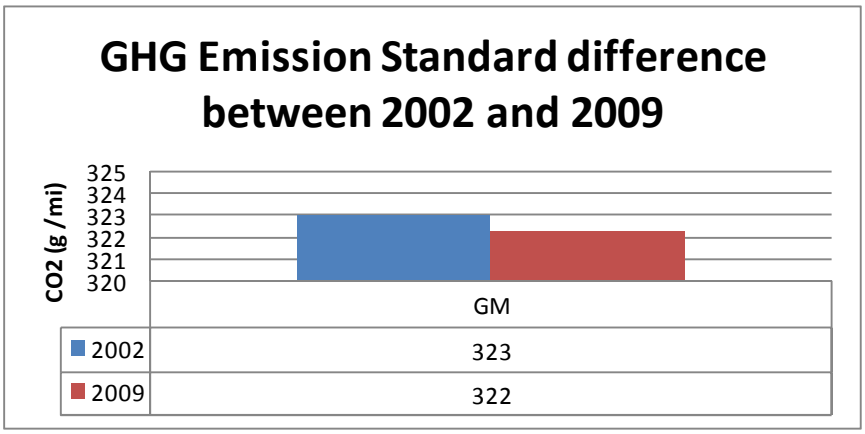


Figure 3.3: GM CO2 (g/mi) difference between 2002 and 2009

B- Toyota

2002											
TW	Model Name	Model No	CID	Disp (L)	MPG	CO2	TW	CW	class	tw*num	CO2*num
2875	COROLLA (U.S.)	27299	109	1,8	38,5	231	2875	2575	PCT1	78484625	6314323
3125	PRIUS	2585	91	1,5	57,6	155	3125	2825	PCT1	8078125	399418,4
3750	AVALON	10130	183	3,0	26,9	331	3750	3450	PCT1	37987500	3351561

2009											
TW	Model Name	Model No	CID	Disp (L)	MPG	CO2	TW	CW	class	tw*num	CO2*num
2875	COROLLA (U.S.)	35478	109	1,8	38,5	231	2875	2575	PCT1	101999250	8206144
3125	PRIUS	26420	91	1,5	57,6	155	3125	2825	PCT1	82562500	4082257
3750	AVALON	1623	183	3,0	26,9	331	3750	3450	PCT1	6086250	536977,7

2002	
Value / Vehicale class	pct1
number	40014
test weight	3113
CO2 (g/mi)	252

2009	
Value / Vehicale class	pct1
number	63521
test weight	3001
CO2 (g/mi)	202

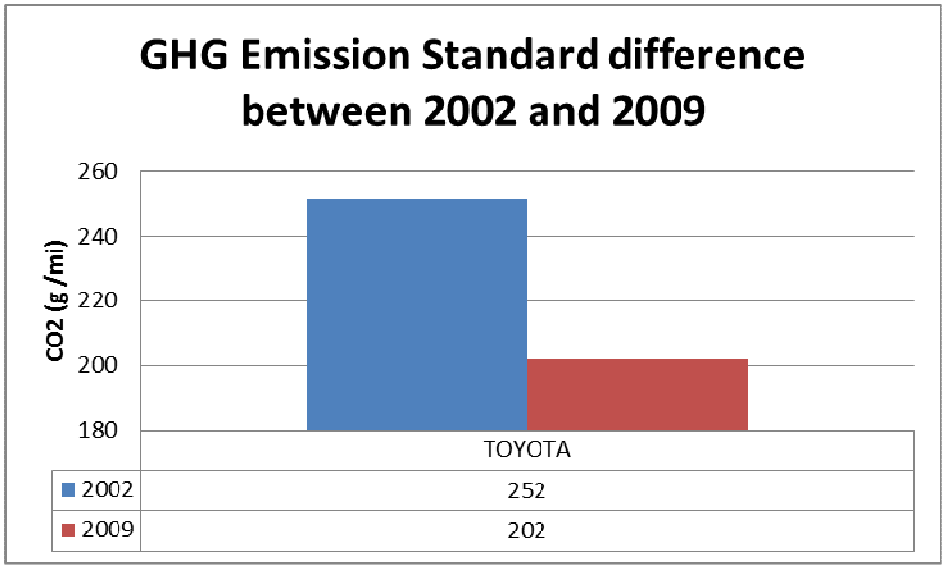


Figure 3.3: TOYOTA CO2 (g/mi) difference between 2002 and 2009

C- FORD

2002											
TW	Model Name	Model No	CID	Disp (L)	MPG	CO2	TW	CW	class	tw*num	CO2*num
3375	ESCAPE	575	121	2,0	28,4	314	3375	3075	PCT1	1940625	180476,8
3375	RANGER	5664	140	2,3	28,9	308	3375	3075	PCT1	19116000	1744406
3500	MUSTANG	16296	232	3,8	25,9	343	3500	3142	PCT1	57036000	5595025

2009											
TW	Model Name	Model No	CID	Disp (L)	MPG	CO2	TW	CW	class	tw*num	CO2*num
3375	ESCAPE	8142	121	2,0	28,4	314	3375	3075	PCT1	27479250	2555552
3375	RANGER	4706	140	2,3	28,9	308	3375	3075	PCT1	15882750	1449360
3500	MUSTANG	4745	232	3,8	25,9	343	3500	3142	PCT1	16607500	1629136

2002	
Value / Vehicale class	pct1
number	22535
test weight	3465
CO2 (g/mi)	334

2009	
Value / Vehicale class	pct1
number	17593
test weight	3409
CO2 (g/mi)	320

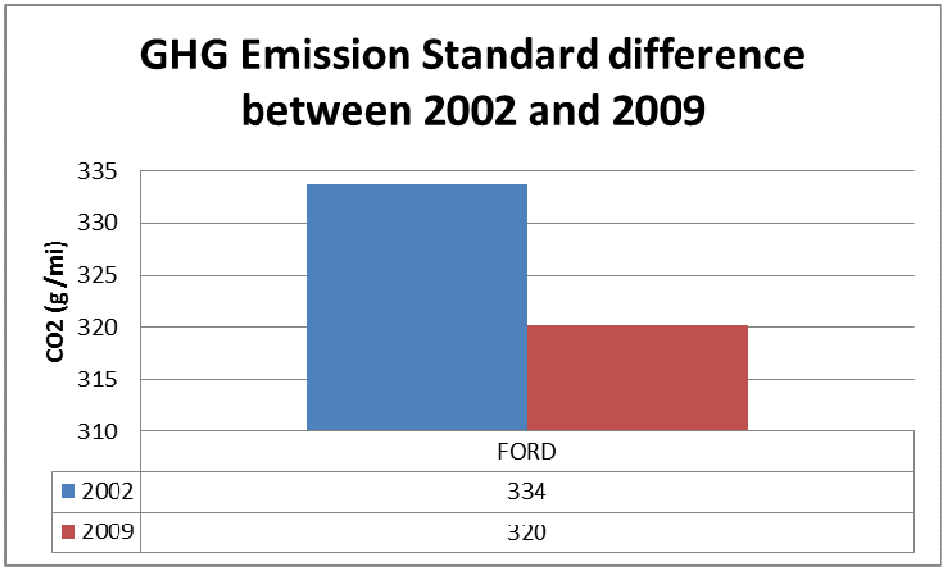


Figure 3.4: FORD CO2 (g/mi) difference between 2002 and 2009

D- HONDA

2002											
TW	Model Name	Model Name	CID	Disp (L)	MPG	CO2	TW	CW	class	tw*num	CO2*num
2125	INSIGHT	183	061	1,0	69,2	129	2125	1887	PCT1	388875	23527,23
2875	CIVIC	54816	102	1,7	39,3	226	2875	2512	PCT1	1,58E+08	12411351
3375	ACCORD	28873	138	2,3	30,2	295	3375	3109	PCT1	97446375	8518372
3500	CR-V	18570	146	2,4	28,2	315	3500	3200	PCT1	64995000	5858107

2009											
TW	Model Name	Model Name	CID	Disp (L)	MPG	CO2	TW	CW	class	tw*num	CO2*num
2125	INSIGHT	2756	061	1,0	69,2	129	2125	1887	PCT1	5856500	354322,6
2875	CIVIC	36351	102	1,7	39,3	226	2875	2512	PCT1	1,05E+08	8230535
3375	ACCORD	32718	138	2,3	30,2	295	3375	3109	PCT1	1,1E+08	9652759
3500	CR-V	19684	146	2,4	28,2	315	3500	3200	PCT1	68894000	6209530

2002	
Value / Vehicale class	pct1
number	102442
test weight	3128
CO2 (g/mi)	262

2009	
Value / Vehicale class	pct1
number	91509
test weight	3166
CO2 (g/mi)	267

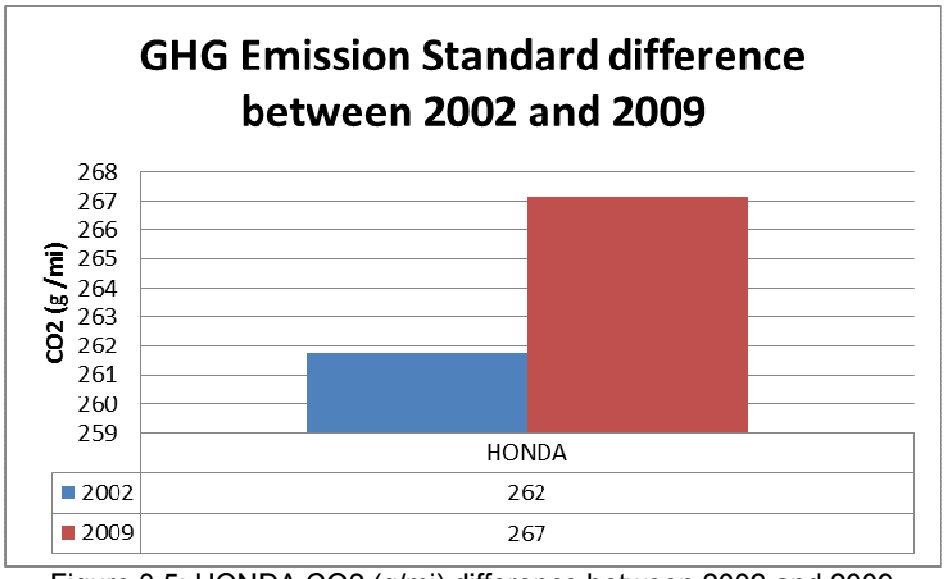


Figure 3.5: HONDA CO2 (g/mi) difference between 2002 and 2009

E- CRYSLER

2002											
TW	Model Name	Model Name	CID	Disp (L)	MPG	CO2	TW	CW	class	tw*num	CO2*num
3500	WRANGLER/TJ	691	150	2,5	21,9	407	3500	3222	PCT1	2418500	281257,7
3875	CHRYSLER 300M	2739	215	3,5	24,4	365	3875	3622	PCT1	10613625	999061,5
4250	CARAVAN	2045	148	2,4	25,6	348	4250	3950	T23	8691250	711392,8
4500	TOWN & COUNTRY	2897	201	3,3	23,6	378	4500	4200	T23	13036500	1094832

2009											
TW	Model Name	Model Name	CID	Disp (L)	MPG	CO2	TW	CW	class	tw*num	CO2*num
3500	WRANGLER/TJ	4811	150	2,5	21,9	407	3500	3222	PCT1	16838500	1958221
3875	CHRYSLER 300M	2258	215	3,5	24,4	365	3875	3622	PCT1	8749750	823614,8
4250	CARAVAN	1320	148	2,4	25,6	348	4250	3950	T23	5610000	459187,5
4500	TOWN & COUNTRY	1413	201	3,3	23,6	378	4500	4200	T23	6358500	534000

2002	
Value / Vehicale class	pct1
number	3430
test weight	3799
CO2 (g/mi)	373

2009	
Value / Vehicale class	pct1
number	7069
test weight	3620
CO2 (g/mi)	394

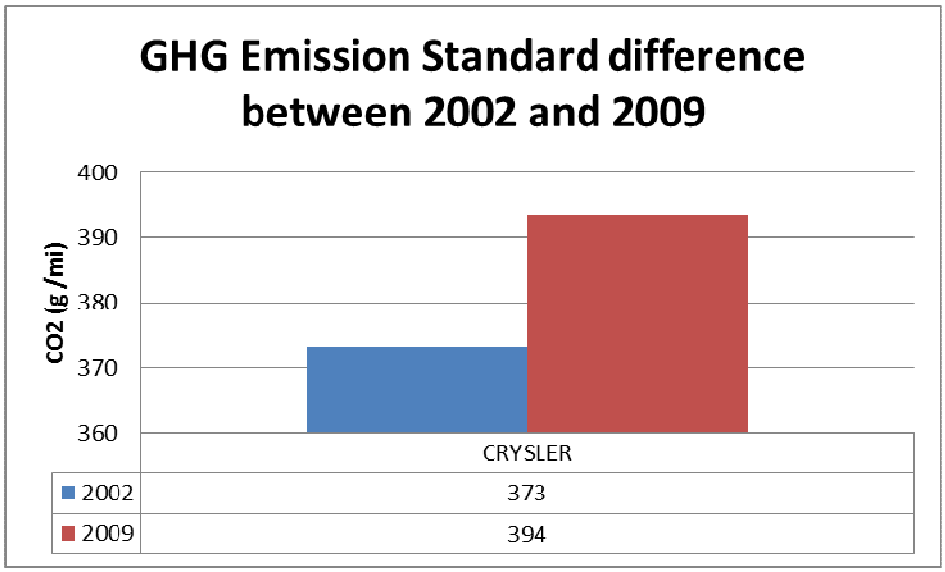


Figure 3.6: CRYSLER CO2 (g/mi) difference between 2002 and 2009

F- NISSAN

2002											
TW	Model Name	Model Name	CID	Disp (L)	MPG	CO2	TW	CW	class	tw*num	CO2*num
3000	SENTRA	13838	108	1,8	35,1	253	3000	2667	PCT1	41514000	3507543
3250	G20	2752	122	2,0	31,0	287	3250	3036	PCT1	8944000	790090,3
3625	FRONTIER	6287	146	2,4	26,2	339	3625	3325	PCT1	22790375	2133153
3625	MAXIMA	6543	214	3,5	26,0	343	3625	3320	PCT1	23718375	2243963
3625	ALTIMA	2962	213	3,5	25,3	351	3625	3316	PCT1	10738990	1040636

2009											
TW	Model Name	Model Name	CID	Disp (L)	MPG	CO2	TW	CW	class	tw*num	CO2*num
3000	SENTRA	13838	108	1,8	35,1	253	3000	2667	PCT1	41514000	3507543
3250	G20	6042	122	2,0	31,0	287	3250	3036	PCT1	19636500	1734639
3625	FRONTIER	2433	146	2,4	26,2	339	3625	3325	PCT1	8819625	825506,8
3625	MAXIMA	2424	214	3,5	26,0	343	3625	3320	PCT1	8787000	831325,9
3625	ALTIMA	14395	213	3,5	25,3	351	3625	3316	PCT1	52181875	5056558

2002	
Value / Vehicale class	pct1
number	32382,48
test weight	3326
CO2 (g/mi)	300

2009	
Value / Vehicale class	pct1
number	39132
test weight	3346
CO2 (g/mi)	306

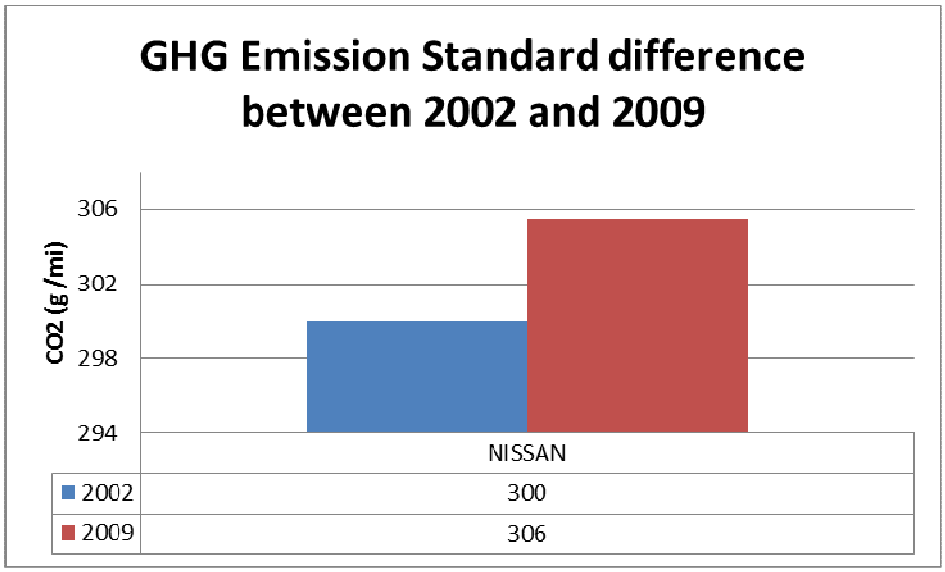


Figure 3.7: NISSAN CO2 (g/mi) difference between 2002 and 2009

4. Finding and result

The main purpose of this section is to discuss and analyzes numbers, tables and diagrams that were produced in the last section. Analyzing these information has lead in determining the main differences between the Proposed and the Actual GHG Emission Standard for PCT1 Vehicle Class. The finding and result of this section is based on the selected vehicles models that were made in the previous section. However, the GHG emission standard, there are three main parameters that play significant role in determining differences. These parameters are: 1- the Number of Sold Cars, 2- The Test Weight Value, and 3- The amount of CO2 (g/mi). Each one of these parameters is discussed in this section with more details.

4.1. The number of sold cars:

The number of sold Cars is an important parameter because this quantity is being used by CARB staff in their Methodology in setting The GHG emission Standard: the number has been used in both equation numbers 1 & 2 that were used in pervious section calculating the GHG emission standard. In both equation number 1&2, the value of sold car is placed as dominator in both equations. This means if the value of sold cars is increasing or decreasing, then a significant change in the final result of the equation will result. As mentioned in the literate review section, the economic recession is correlated with the number of sold cars. When the economic recession knockout California's market, the number of sold cars was declined causing difficulty for automakers to adhere the proposed standard. However, the table below represents the number of sold cars (Pct1) for the selected vehicles models by each major company. Also it shows the total number of sold cars for six major companies together.

Emission Standards for PCT1			
	MODEL No.		Percent Difference
Year	2002	2009	MODEL No.
GM	20647	7160	-65.32%
FORD	22535	17593	-21.93%
CRYSLER	3430	7069	106.09%
TOYOTA	40014	63521	58.75%
HONDA	102442	91509	-10.67%
NISSAN	32382	39132	20.84%
Total	221450.5	225984	2.05%

Table 4.1: the number of sold cars per company

Analyzing the information from the above table, it can be easily observed that the number of sold cars in 2009 was increased by 2.05% than the number of sold cars in

2002. This 2.05% includes a decline in the number of sold cars for three companies: GM, FORD, and HONDA, and an increasing for the other three companies: TOYOTA, NISSAN and CRYSLER. The below diagram shows the sold cars' number in 2002 and 2009 for each company, and the total number of sold cars for the six major companies together.

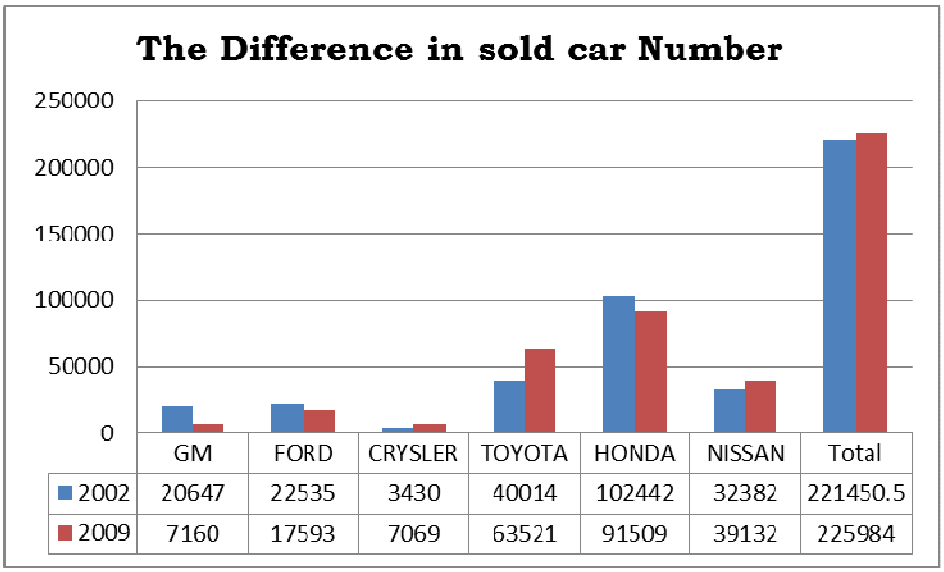


Figure 4.1: The difference in Sold Car Number

Also, in the below diagram, the percent difference in sold cars of 2002 and 2009 is represented. The diagram shows a total increase of 2.o5% in PCT1 vehicle class

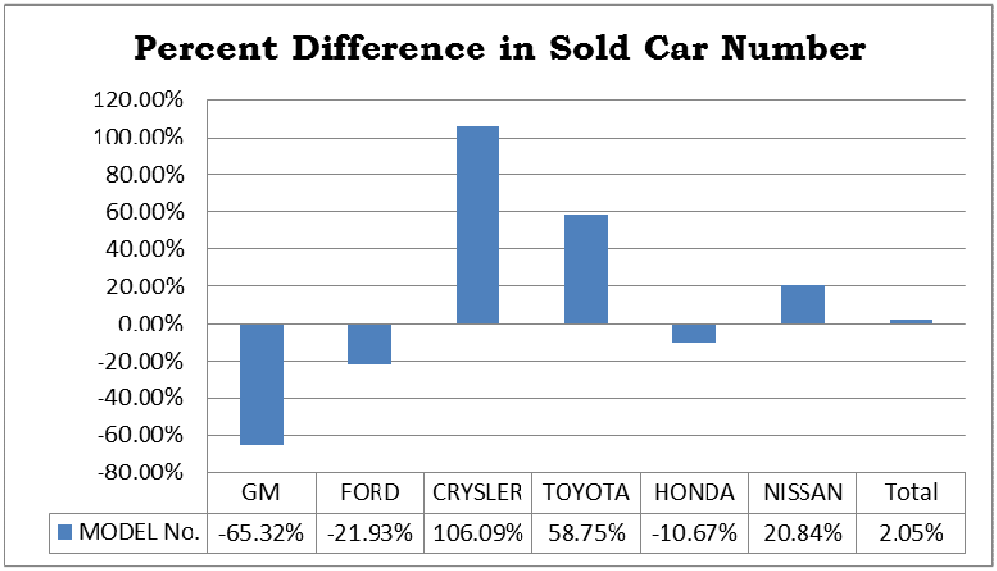


Figure 4.1.1: The percent difference in Sold Cars Number

4.2. Test weigh value:

The Test Weight Value is another important parameter that play significant role in determining the GHG emission standard. The test weight is the loaded vehicle weight at which emissions performance is tested. Basically the GHG emission standard is a function of test weight. The values of test weight for selected PCT1 vehicle class are represented in the below table. In 2009, the Average test weight value is 3335, compared with a 3391 in 2002. There is a small percent of decline which is 1.66%. This decline percent includes a decline in test weight value for four companies: GM, FORD, CRYSLER, and TOTOTA. Also it includes an increase in test weight value for other companies: HONDA and NISSAN.

Emission Standards for PCT1			
	Test Weight		Percent Difference
Year	2002	2009	Test Weight
GM	3513	3466	-1.33%
FORD	3465	3409	-1.64%
CRYSLER	3799	3620	-4.73%
TOYOTA	3113	3001	-3.58%
HONDA	3128	3166	1.21%
NISSAN	3326	3346	0.60%
Average	3391	3335	-1.66%

Table 4.2: The difference in test weight value

The most decline percent in test weight value was for CRYSLER and TOYOTA. In contrast, the most increased in test value was for HONDA. However, the declined percent in these four companies were greater than the increased percent in other two companies forcing the average of test value for the six major companies to be negative which mean less than the average of test weight value for same companies in 2002.

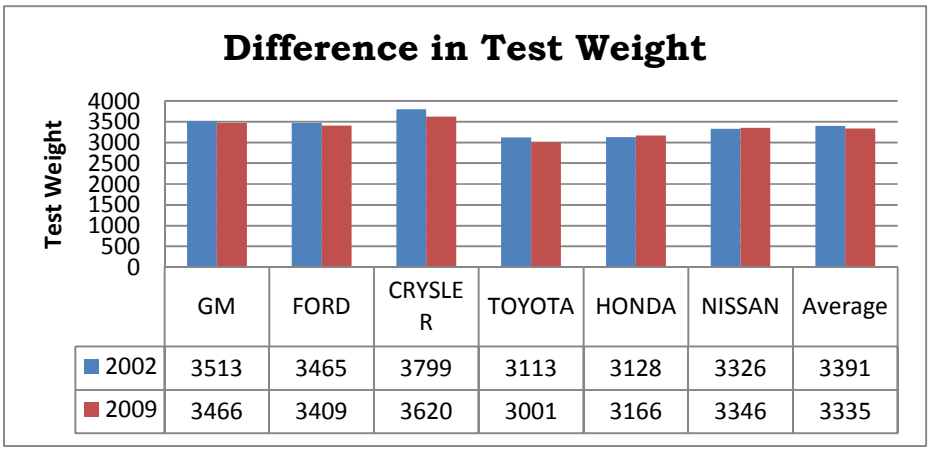


Figure 4.2: The difference in test weight value

The following diagram represents the percent difference in test weight value for each auto company between 2002 and 2009. It also shows how these values have negative or positive values. Finally the diagram shows a negative value of test weight for the average of the six major auto companies together.

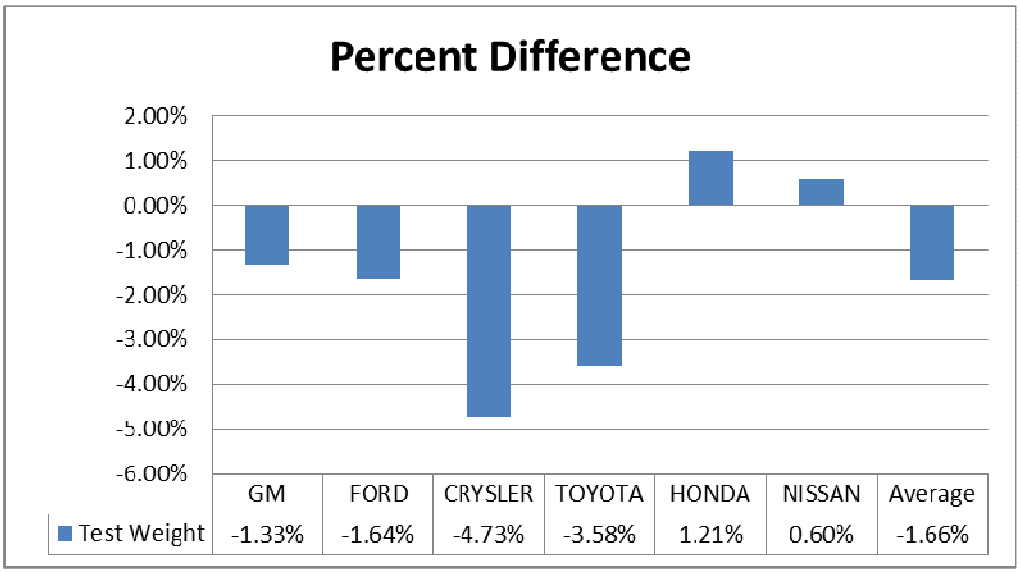


Figure 4.2.1: The Percent difference in test weight value

4.3. The value of CO2 (g/mi):

Another important parameter in the GHG emission standard is the amount of CO2 in (g/mi). The automakers must be aware of this in order for them to be incompliance with the standard. This value can be determined by the following equation:

The final value of CO2 (g/mi) for company = sum of total CO2*num / sum of Model No.

However, form the calculation section, the value of CO2 for the selected PCT1 vehicle class is represented in the following table. The table shows that there is a decline in the average value of CO2 for six major companies together in 2009 that the same value in 2002. In 2009, the average value of CO2 (g/mi) for the six major companies together was 302, in contrast, the average value of CO2 for the same companies was 307.

Emission Standards for PCT1			
	CO2 (g/mi)		**Percent Difference**
Year	**2002**	**2009**	**CO2 (g/mi)**
GM	323	322	-0.22%
FORD	334	320	-4.03%
CRYSLER	373	394	5.43%
TOYOTA	252	202	-19.73%
HONDA	262	267	2.08%
NISSAN	300	306	1.83%
Average	307	302	-1.77%

Table 4.3: the difference in CO2 Value

When plotting the information from the above table into the below diagram, it was obviously that the most decline in the value of CO2 was happening for Toyota company. In contract, the most increase value of CO2 was happing to Honda Company.

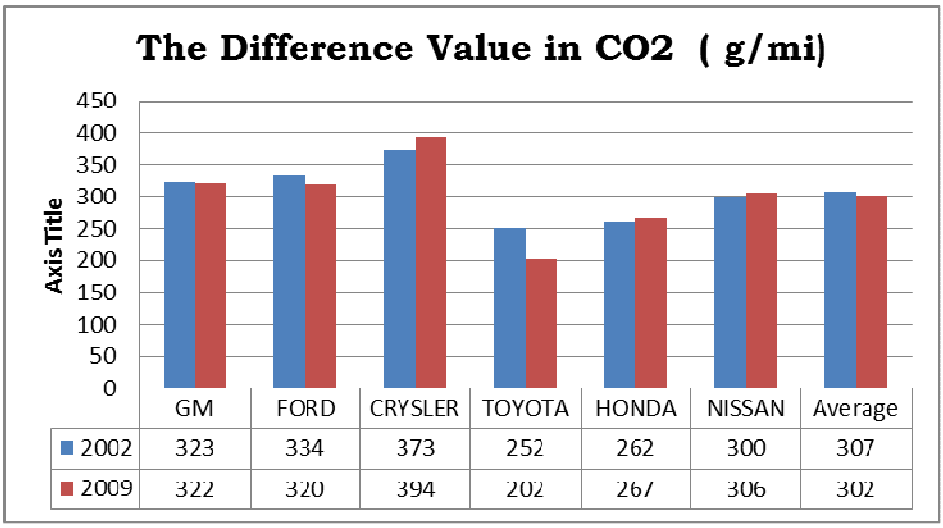


Figure 4.3: the difference in CO2 Value

The percent difference of CO2 between 2002 and 2009 is plotted in the following diagram. The percent decline of 1.77% represents the difference of CO2 between 2002 and 2009 for selected vehicle class.

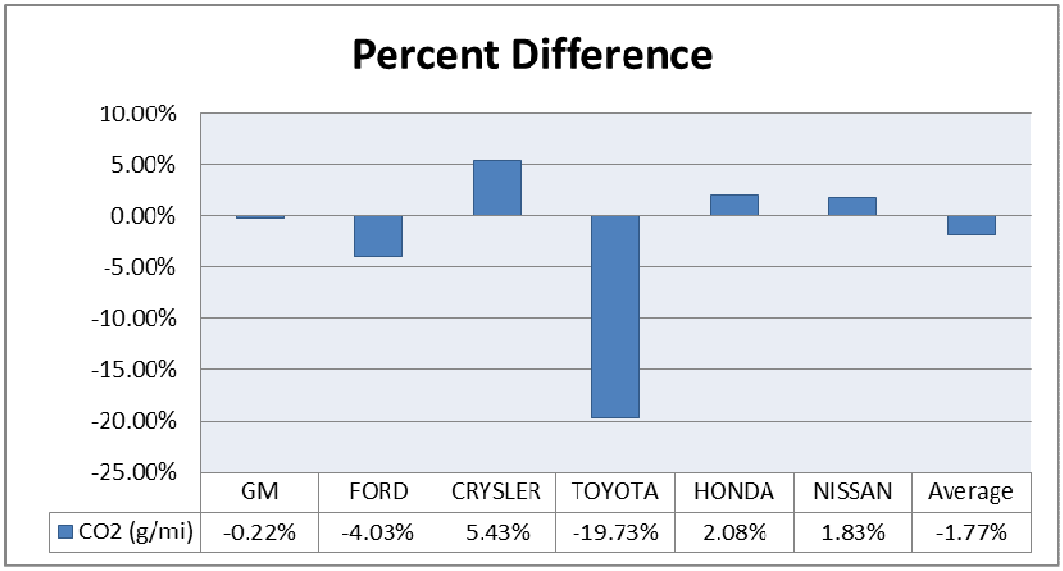


Figure 4.3: the Percent difference in CO2 Value

4.4. Percent difference for six major companies together

Table 4-4 and Diagram 4-4 represents percent difference of proposed and Actual GHG emission standard for selected PCT1 vehicles between 2002 and 2009 for six major companies together. The table includes value of CO2 in (G/mi), the number of sold cars, and finally the Test Weight value.

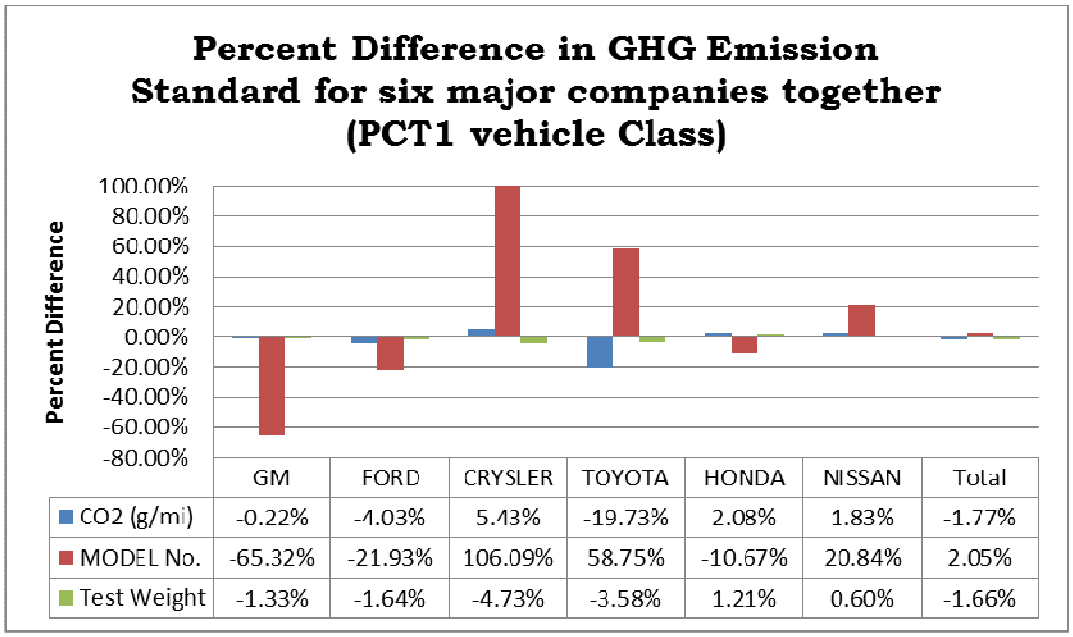
Emission Standards for PCT1									
	CO2 (g/mi)		MODEL No.		Test Weight		Percent Difference		
Year	2002	2009	2002	2009	2002	2009	CO2 (g/mi)	MODEL No.	Test Weight
GM	323	322	20647	7160	3513	3466	-0.22%	-65.32%	-1.33%
FORD	334	320	22535	17593	3465	3409	-4.03%	-21.93%	-1.64%
CRYSLER	373	394	3430	7069	3799	3620	5.43%	106.09%	-4.73%
TOYOTA	252	202	40014	63521	3113	3001	-19.73%	58.75%	-3.58%
HONDA	262	267	102442	91509	3128	3166	2.08%	-10.67%	1.21%
NISSAN	300	306	32382	39132	3326	3346	1.83%	20.84%	0.60%
Total	307	302	221450.5	225984	3391	3335	-1.77%	2.05%	-1.66%

Table 4.4: the percent difference for six major companies

Based on the information from table 4.4, many observations can be outlined as follow:

1- There are more sold cars for PCT1 vehicles in 2009 than 2002. The percent difference in the number of sold car for six major companies together between 2009 and 2002 is 2.95%. This value represents a decline in sold cars number for three companies: GM, FORD, and Honda. Also it represents an increased in sold cars number for the other three companies: TOYOTA, NISSAN, and CRYSLER. The most decline present in sold cars number occurred for the General Motor Company, In contrast, the most increased percent occurred for CRYSLER, then TOYOTA Company.
2- The average value of CO2 (g/mi) for PCT1 Vehicles in 2009 is less than the same value of 2002 by 1.77%. The decline of 1.77% was a result of decline in the value of CO2 for three companies: GM, FORD, and TOYOTA. Also as a result of increasing in the value of CO2 for the other three companies: CRYSLER, NISSAN, and HONDA. The highest increased in the value of CO2 was occurring for CRYSLER company, in contrast, the lowest of the same value was occurring for TOYOTA company.

3- The average value of test weight for PCT1 vehicles in 2009 is less than the same value of 2002 by 1.66%. The decline of 1.66% was a result of decline in the value of test weight that was occurring for four companies: GM, FORD, CRYSLER and TOYOTA, and an increased of Test Weight value for the other two companies: NISSAN and HONDA.



	GM	FORD	CRYSLER	TOYOTA	HONDA	NISSAN	Total
CO2 (g/mi)	-0.22%	-4.03%	5.43%	-19.73%	2.08%	1.83%	-1.77%
MODEL No.	-65.32%	-21.93%	106.09%	58.75%	-10.67%	20.84%	2.05%
Test Weight	-1.33%	-1.64%	-4.73%	-3.58%	1.21%	0.60%	-1.66%

Diagram 4.4: Percent Difference in GHG Emission Standard for six major companies together (PCT1 vehicles)

From figure 4.4, it is obvious that the economic recession has negative impacts on three companies: GM, FORD, and HONDA resulting in a decline in total number of PCT1 sold Vehicle. In contrast, the economic recession has not affected the other three companies: CRYSLER, TOYOTA and NISSAN because they had sold more PCT1 vehicle in 2009 than in 2002. Furthermore, looking at the effect of economic recession on the total number of sold PCT1 for the six major companies together, it is obvious that there is no effect since there was still increase in the sold cars for the six major companies together in 2009 than 2002 by 2.05%. Another piece of evidence is that there is still a decline in both of CO2 and test weight values in 2009 than 2002 for the six major companies together even though there is an increase of sold PCT1 vehicles. This is an absolute confirmation that the methodology employed by California Air Resource Board in setting the proposed GHG emission Standard is valid under the current economic recession circumstances.

Conclusion

This research was written to evaluate the impact of the economic recession on the California Air Resource Board (CARB) strategy for reducing current greenhouse gas (GHG) emissions from motor vehicles.

In 2002, the CARB staff realized that the GHG produced by motor vehicles in California State is one of many reasons behind the increased climate change. As a result, the staff decided to set GHG standards that reduce the amount of GHG from motor vehicles. In addition, The California Air Resources Board (CARB) published a report in August, 2004 with recommendations for greenhouse gas (GHG) emissions reductions in newly manufactured passenger cars and light-duty trucks. The CARB report and the subsequent regulations recommended by it were directed by California State Assembly bill AB 1493 passed in 2002. The regulations would require new automobiles sold in California to adhere to decreasing emissions with each subsequent model year beginning in 2009 and ending in 2016.

However, because the CARB staff used the Model-2002 vehicle fleet data for six major auto companies (GM, TOYOTA, FORD, HONDA, NISSAN, and CRYSLER) , and the market conditions of 2002 in setting the GHG emission standard, there was a belief that the current economic recession has altered the current economic condition in California. Thus the proposed GHG emission standard would not be valid under the current economic recession conditions. In different words, the objectives of GHG emission standard in reducing GHG emission from Motor vehicles would not be met, if the automakers had followed the proposed standard.

To examine the hypothesis in this study, the actual-2009 GHG emission standard for specific vehicle names of passenger and light duty cars was recalculated, using the same methodology employed by CARB in setting the proposed standard, and then compared with the proposed GHG emission standard for the same year.

The total number of sold cars, value of CO2 in gram per mile (g/mile) and value of Test Weight for GHG emission standard were the most three parameters that was used in this study in comparing the actual-2009 GHG with proposed emission standard.

The finding and result of this research paper has shown that the number of PCT1 sold cars for the actual-2009 GHG emission standard for six major companies together had increased than the same number for the proposed GHG emission standard by 2.05% (4534 cars). Also, decline in the Value of CO2 (g/mi) by 1.66%, and test weight by 1.77%.

From the above finding, it can be concluded that the proposed GHG emission standard by CARB for PCT1/LDT1 category in 2009 was valid even though some automakers had separately experienced declined in sold cars in their fleet as a result of the economic recession. For example, The GM, FORD and HONDA companies had experienced a decline in PCT1 Sold Cars while the rest of other companies had experienced an increase. Another piece of evidence is that there was still a decline in both of CO2 and test weight values in the actual 2009 GHG emission standard than 2002 standard for the six major companies together even though there was an increase of sold PCT1 vehicles. In few words, the proposed GHG emission standard by CARB was valid only for PCT1 vehicles' category in 2009. However, the question that should be asked in order to continue this research paper would: what about the other vehicles category, light duty trucks (LDT2)? Does the proposed GHG standard still be valid for that category in 2009?, and if yes? What about for both categories: PCT1/LDT1 , and LDT2?. The fact that the proposed GHG emission standard for PCT1 category in 2009 was valid it does not mean that it will be valid for other category, or both categories until otherwise is proven.

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